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ABSTRACT

As a part of the REACH (Refrigeration, Electro-Mechanical, Air-Conditioning, Heating) electromechanical cluster, this student manual contains individualized instructional units in the area of major appliances. The instructional units focus on installation of appliances, troubleshooting washing machines, troubleshooting electric dryers, troubleshooting automatic dishwashers, and troubleshooting electric ranges. Each unit follows a typical format that includes a unit sheet, information sheets, assignment sheets, and job sheets. The unit sheet is designed to guide the learner through each task and is comprised of two main sections. The first lists all information needed to identify the task and the sequence in which activities are performed. The second section identifies each activity. (Related teacher's guides are available separately as CE 026 352-355.) (LRA)

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James F. Watkins

# REACH

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MAJOR APPLIANCE

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| Troubleshooting Washing Machines MA-10 - MA-15 | Charles English, Haralson County Comprehensive High School |
| Troubleshooting Electric Dryers MA-16 - MA-17 | Charles English, Haralson County Comprehensive High School |
| Troubleshooting Automatic Dishwashers MA-18 - MA-25 | Jimmy Ansley, Thomson High School |
| Troubleshooting Electric Ranges MA-26 - MA-27 | Melvin Braswell, Tri-County High School |
| Troubleshooting Electric Ranges MA-28 - MA-31 | Jimmy Ansley, Thomson High School |

# TEXT ASSIGNMENT SHEET

MAJOR APPLIANCE (MA)

| ASSIGNMENT NO. | TEXT NO. | PAGES | STUDY ASSIGNMENT |
|---|---|---|---|
| MA-01a | 7 | 199-201 | Read and study illustrations |
| MA-02a | 7 | 202-204 | Read and study illustrations. |
| MA-03 | No Text Assignment | | |
| MA-04 | No Text Assignment | | |
| MA-05 | No Text Assignment | | |
| MA-06 | No Text Assignment | | |
| MA-07 | No Text Assignment | | |
| MA-08 | No Text Assignment | | |
| MA-09 | No Text Assignment | | |
| MA-10 | No Text Assignment | | |
| MA-11 | No Text Assignment | | |
| MA-12 | No Text Assignment | | |
| MA-13a | 8 | 225-227 | Read section on "Troubleshooting" to "Water Does Not Enter Tub" |
| MA-14 | No Text Assignment | | |
| MA-15 | No Text Assignment | | |
| MA-16 | No Text Assignment | | |
| MA-17 | No Text Assignment | | |
| MA-18 | No Text Assignment | | |

TEXT ASSIGNMENT SHEET

MAJOR APPLIANCE (MA)

| ASSIGNMENT NO. | TEXT NO. | PAGES | STUDY ASSIGNMENT |
|---|---|---|---|
| MA-19 | No Text Assignment | | |
| MA-20a | No Text Assignment | | |
| MA-21a | 8 | 309-313 | Read section 13.6 "Troubleshooting" |
| MA-22a | No Text Assignment | | |
| MA-23a | 8 | 316-318 | Study illustration and read sections on pump. |
| MA-24a | 8 | 307-308 | Read section 13.4 "Cycle of Operation" and study diagrams |
| MA-25a | 8 | 312-313 | Study troubleshooting chart |
| MA-26a | No Text Assignment | | |
| MA-27a | 9 | 252-256 | Read sections 10.5 to 10.11 |
| MA-28 | No Text Assignment | | |
| MA-29a | 9 | 293-297 | Read sections 11.14 and 11.15 on thermostats |
| MA-30a | 9 | 297-299 | Read sections 11.17 and 11.18 on timers |
| MA-31 | No Text Assignment | | |

**MAJOR BLOCK** MAJOR APPLIANCES **NAME** _____

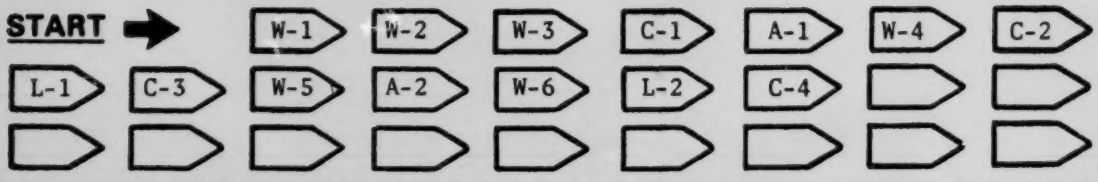
**TASK** Installation of Appliances

**UNIT** Installing ELectric Range **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-01

**OBJECTIVE(S)**

Run power and install electric range




**WRITTEN ASSIGNMENT(S)**

| | |
|---|---|
| W-1 | Text Assignment MA-01a |
| W-2 | Information Sheet MA-01a |
| W-3 | Assignment Sheet MA-01a |
| W-4 | Assignment Sheet MA-01b |
| W-5 | Information Sheet MA-01c |
| W-6 | Information Sheet MA-01d |
| W-7 | |

**AUDIOVISUAL(S)**

| | |
|---|---|
| A-1 | Slide/Tape MA-01a |
| A-2 | Slide/Tape MA-01b |
| A-3 | |
| A-4 | |
| A-5 | |
| A-6 | |
| A-7 | |

**LABORATORY ASSIGNMENT(S)**

| | |
|---|---|
| L-1 | Job Sheet MA-01a |
| L-2 | Job Sheet MA-01b |
| L-3 | |
| L-4 | |
| L-5 | |
| L-6 | |
| L-7 | |
| L-8 | |
| L-9 | |

**CHECKPOINT(S)**

| | |
|---|---|
| C-1 | Instructor Check |
| C-2 | Instructor Check |
| C-3 | Instructor Check |
| C-4 | Instructor Check |
| C-5 | |
| C-6 | |
| C-7 | |
| C-8 | |
| C-9 | |

HOW TO SELECT PROPER WIRE SIZE, TYPE, AND RECEPTACLE

The National Electric Code (NEC) has established minimum requirements for safe installation and wiring of electric ranges. To insure safe operation of the unit, the size and type of wire, number of conductors, and amperage rating of receptacle must meet NEC requirements. The student is cautioned to follow this code and any local codes pertaining to installation and wiring of appliances.

I. Reading the Dataplate

The first step in determining what the requirements are is to locate the range data plate (see figure A). The dataplate will be attached to the range and will contain specific information. Figure A shows that this particular range is rated at 9.6 kw or 7.2 kw depending on the line voltage. Also, this requires three conductors. Note that the dataplate does not show amperage rating.

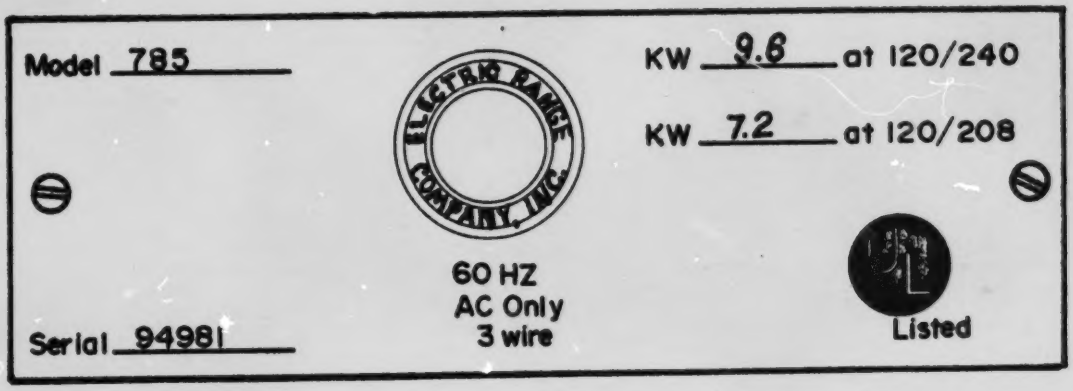



FIGURE A
RANGE DATA PLATE

II. Using the Power Formula

The amperage draw, or "load", of the electric appliance determines the minimum size and type of wire to be used. Since the dataplate does not state the amperage rating, then it must be figured by using the power formula (see figure B) and other information on the dataplate (figure A) as shown:

1. Determine what the line voltage is.

2. Convert kilowatts to watts.

3. P(watts) and E(volts) are known, what is I?

4. $\frac{P}{E} = I$

5. $\frac{9600 \text{ (from step 2)}}{240 \text{ (from step 1)}} = I$

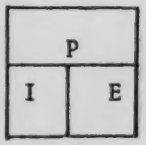
6. I = 40 amperes connected load

Forty amps is the connected load of the range, however, in determining minimum wire sizes the demand load must be figured. The demand load will be less than the connected load depending on the kilowatt rating of the range. Turn the page to figure demand load on this range.

P = Watts

I = Amperage

E = Voltage




$\frac{P}{I} = E$

$\frac{P}{E} = I$

$I \times E = P$

FIGURE B

POWER FORMULA

III. Using the NEC Table 220-19

The National Electric Code (NEC) must be used in determining demand loads. Figure C is a portion of table 220-19 of the NEC. It is noted that if a range is not over 12 kw then the maximum power demand is based on column A of the table. Since the range used in this example is not more than 12 kw then maximum demand is based on 8 kw.

Using the power formula maximum demand load can be figured.

1. $\frac{P}{E} = I$

2. $\frac{8000 \text{ (from column A)}}{240 \text{ (line volts)}}$

3. I = 33.3 amperes demand load

| NUMBER OF APPLIANCES | Maximum Demand | Demand Factors Percent | |
|---|---|---|---|
| | Column A (Not over 12 kW rating) | Column B (Less than 3½ kW rating) | Column C (3½ kW to 8 3/4 kW rating) |
| 1 | 8 kW | 80% | 80% |
| 2 | 11 kW | 75% | 65% |
| 3 | 14 kW | 70% | 55% |

FIGURE C

TABLE 220-19 NEC

IV. Using the NEC Table 310-16

Now that the demand load has been determined the minimum wire size and type can be selected. Table 310-16 (see figure D) of the NEC is used.

1. Determine what type of wire is to be used?
2. Now looking down the wire type column find a figure that is closest but not less than the demand load.
3. Look to the left of the 40 and locate wire size.

From all the preceding information wire size, type, and number of conductors has been determined.

Wire size - #8
Type - TW
Number of conductors - 3 (from dataplate)

| Size | Temperature Rating of Conductor | | | |
|---|---|---|---|---|
| | 60°C (140°F) | 75°C (185°F) | 85°C (185°F) | 90°C (194°F) |
| | TYPES RUW, T, TW, UF | TYPES FEPW RH, RHW, RUH THW, THWN, XHHW, USE, ZW | TYPES V, MI | TYPES TA, TBS, SA AVB, SIS, RHH, THHN XHHW |
| | COPPER | | | |
| 14 | 15 | 15 | 25 | 25 |
| 12 | 20 | 20 | 30 | 30 |
| 10 | 30 | 30 | 40 | 40 |
| 8 | 40 | 45 | 50 | 50 |

FIGURE D
TABLE 310-16 NEC

V. Determining loads greater than 12 kw

There are many times when the service technician installs a range that will be rated more than 12 kw. In these instances the technician should refer to Note 1, from table 220-19 of the NEC, it states: "... the demand in column A shall be increased five per cent for each additional kw rating ... by which the rating of individual ranges exceeds 12 kw."

The following procedure would be used for a range with a rating of 18 kw at 120/240 volts.

1. 18,000 - 12,000 = 6,000 watts or 6 kw
2. 5% increase for each kw = 30% increase
3. 8 kw from column A x .30 = 2.4 kw
4. 8 kw from column A + 2.4kw = 10.4 kw (calculated load)
5. $\frac{P}{E} = I$
6. $\frac{10400}{240}$ = 43.3 amps (demand load)
7. Table 310.16 of the NEC shows that a size #6 wire, type TW is the minimum wiring requirement for this range.

Assignment Sheet MA-01a

Given the following information and NEC, calculate the size and type of wire, number of conductors, and amperage rating of receptacle. Use information sheet MA-01a as a guide. Do all work on this page.

Problem #1

A. Size and type of ungrounded wire ____

Size and type of grounded wire ____

B. Number of conductors ____

C. Amperage rating of receptacle ____

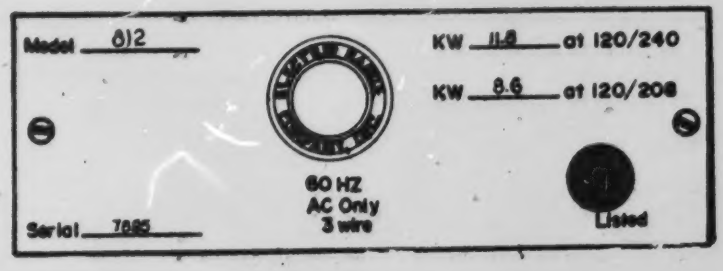



FIGURE E

Problem #2

A. Size and type of ungrounded wire ____

Size and type of grounded wire ____

B. Number of conductors ____

C. Amperage rating of receptacle ____

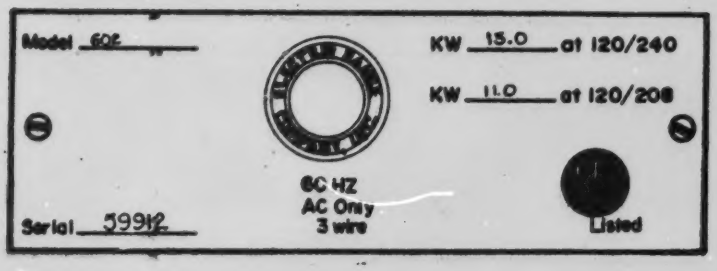



FIGURE F

## HOW TO RUN WIRE, INSTALL RECEPTACLE, AND CONNECT TO DISTRIBUTION PANEL

When installing a range receptacle be sure to select the proper size of wire, type of wire, and receptacle (flush or surface mount). Next, choose the right location to mount the receptacle so that the range will go all the way back and flat against the wall. The proper position for receptacles are usually 18" from the floor). The wire used in most places to connect range receptacles is Type SE or Service Entrance Cable or type TW romex. The uninsulated stranded wire in this cable is the neutral and is connected to the outer terminals. When connecting this cable in distribution panel, connect the stranded uninsulated wire to the ground strip terminal and the two insulated wires to the correct size fuse block or breaker. Make all connections tight and complete the installation as neat as possible.

Use the distribution panel and range receptacle below to draw circuits and show connections for complete range circuit. Draw and label the necessary wires into their appropriate position and label the size type and colors. Have instructor check drawing.

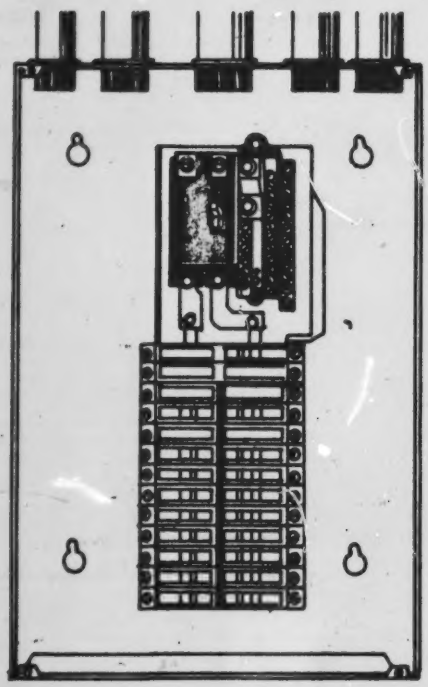
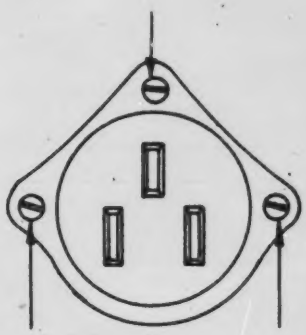


FIGURE G



1. Record information from the range to be installed in table A below.
2. Consult National Electric Code (NEC) for minimum wiring requirements and calculate information for Table B.
3. Make a list of materials needed to wire circuit.
4. Secure materials from storeroom.
5. Go to wiring panel and wire complete circuit for range.
6. Have instructor check your work.

Table A

Range to be installed:

Model _____

Serial #_____

kW_____ (120/240)

kW_____ (110/208)

Table B

A. Size and type of ungrounded wire _____

B. Size and type of grounded wire _____

C. Number of conductors _____

D. Amperage rating of receptacle _____

UNPACKING AND INSTALLING ELECTRIC RANGE

1. Remove carton from range by cutting the carton with a sharp box opener 1" from floor on all four sides. Life the carton from the range carefully.

2. To remove the wood base, lay the range on its back on a soft pad and remove the shipping bolts. NOTE: Some manufacturers use the appliance leveling screws to secure the appliances to the shipping base. When the base has been removed, turn the leveling screws completely into the base of range. Final leveling will be done when the range is in its proper location.

3. Set the range upright on its base and install the range cord making sure that the range grounding strap is connected to the neutral of range cord or to appropriate ground wire. The center or white wire on the range cord is the neutral wire. The range is now ready for installation.

4. Truck the range from the side with appliance dolleys being careful not to tighten the strap on dolley too tight. It may chip the porcelain on the doors. Move the range to its final installation site with the appliance dolley. Be careful when passing through doors and by other appliances so as not to damage other furniture. The range should be on the floor as close as possible to the point of installation. Remove appliance dolley and plug the range cord into the receptacle. Slide the range in place being careful not to scratch or damge the floor because a damaged floor can lose a good customer. When the range is in place, make final adjustment on leveling screws with a level placed on top of the range. Level both front to back and side to side.

5. When installation is complete remove all packing from the range and check for proper operation. Clean up area.

6. Instruct customer on proper operation and care of range.

7. Give customer use and care book, warranty information, and phone number of dealer to call for service.

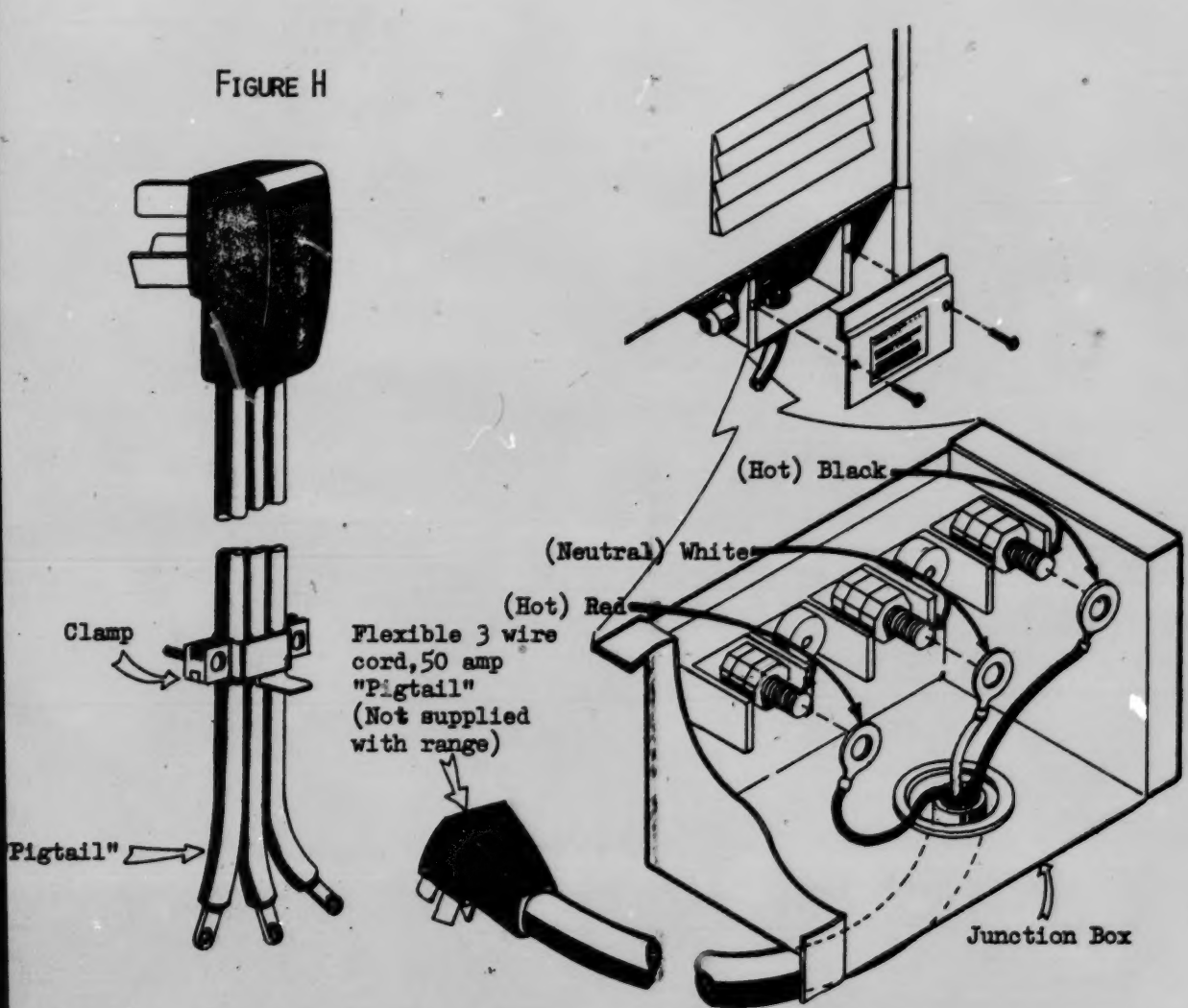
HOW TO INSTALL RANGE CORD

The term "pig-tail" is generally used to describe the range cord (See Figure 1). Often the manufacturer of the range does not furnish the pig tail but leaves this up to the service man to supply and install.

If it is determined that a 50 amp receptacle is to be used, a range cord of not less than 50 amperes must also be used.

Wiring instructions are generally located on the back of the range or in the installation booklet. As shown in Figure 2 the white or neutral wire is connected to the center post. The frame of the range may also be grounded to the same connection. NOTE: Some local codes do not allow grounding of the frame in this manner, be sure to consult the local code. Connect the remaining wires, red and black, to their respective posts. The cord will have a clamp that must be installed to prevent excessive pressure on the connections. (See Figure 1).

FIGURE H



Refer to Information Sheet MA-01d. Obtain range cord from store room and install. When installation is completed have instructor check your work.

After installation of the range cord is complete the next step is to test the range for all phases of operation. Refer to the following steps:

1. Make sure all units are turned off.
2. Plug range cord into the receptacle.
3. Level range by adjusting leveling screws. (A-level will be needed).
4. Open the oven door and check for any packing material that may have been left inside.
5. Check oven by setting controls on "Bake" at 400$^{O}$F and determine if lower element glows. NOTE: Some range ovens will have a "pre-heat" setting, upper and lower elements will glow when the selector is set on preheat at 400 degrees F. Next, switch selector to "Broil" and determine if upper element glows. As oven reaches set temperature the oven indicator light should go out.
6. Check oven light.
7. Place clock setting on "automatic" and manually turn clock through complete cycle to determine control of oven or buzzer.
8. Turn off oven and turn on all burners to low position. Check operation by holding palm of hand two inches from burner.
9. Turn off oven and turn on all 4 burners to low position and check to see if outer ring heats, next, turn each switch to "medium" position to see that each inner ring heats.
10. Check convenience outlet with test lamp.
11. Check warmer unit (if applicable) for heating by turning on warmer switch and feeling warmer drawer.

**MAJOR BLOCK** Major Appliance **NAME** _____

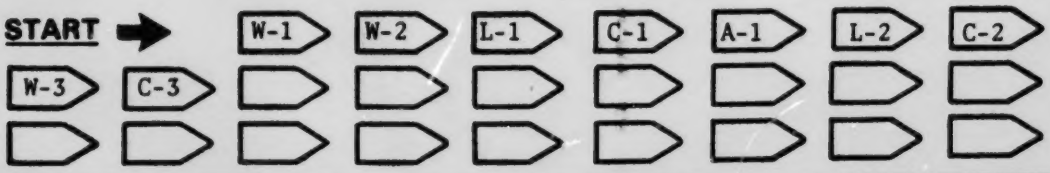
**TASK** Installing Appliances

**UNIT** Installing Oven **TIME (est.)** _____ **(act.)** _____

**UNIT NO.** MA-02

**OBJECTIVE(S)**

Install wall oven according to the minimum requirements of the National Electric Code.




**WRITTEN ASSIGNMENT(S)**

| | |
|---|---|
| W-1 | Text Assignment MA-02a |
| W-2 | Information Sheet MA-02a |
| W-3 | Assignment Sheet MA-02b |
| W-4 | |
| W-5 | |
| W-6 | |
| W-7 | |

**AUDIOVISUAL(S)**

| | |
|---|---|
| A-1 | SLide Set MA-02a |
| A-2 | |
| A-3 | |
| A-4 | |
| A-5 | |
| A-6 | |
| A-7 | |

**LABORATORY ASSIGNMENT(S)**

| | |
|---|---|
| L-1 | Job Sheet MA-02a |
| L-2 | Job Sheet M02b |
| L-3 | |
| L-4 | |
| L-5 | |
| L-6 | |
| L-7 | |
| L-8 | |
| L-9 | |

**CHECKPOINT(S)**

| | |
|---|---|
| C-1 | Instructor Check |
| C-2 | Instructor Check |
| C-3 | Instructor Check |
| C-4 | |
| C-5 | |
| C-6 | |
| C-7 | |
| C-8 | |
| C-9 | |

When installing electric ovens the technician must first obtain a copy of the National Electric Code (NEC). The index in the back of the NEC will help locate the information needed to wire the oven.

In the index, under the heading"ovens, wall-mounted," the technician will find the specific articles that deal with minimum requirements. The technician then computes the correct wire size and type and protection device, required for the installation, using the power formula and information on the oven data plate.

After minimum requirements have been decided measure the amount of wire needed and prepare a sketch of the wire location through joists or studs and walls (see Figure A).

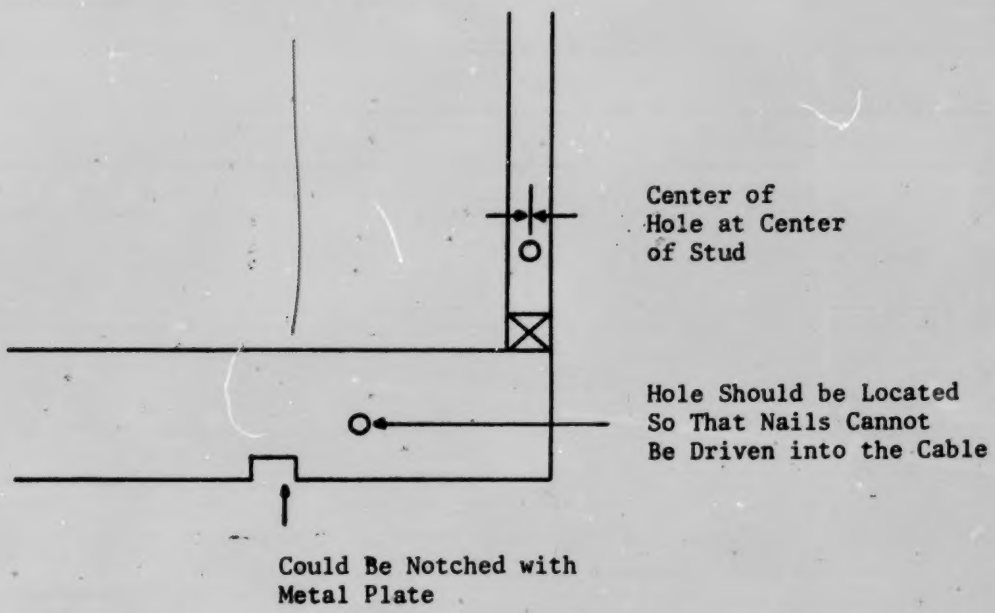



FIGURE A

Wire Installation Sketch

The necessary holes are then drilled and the cable is pulled through from the installation site to the service panel. Either a receptacle or a "J" box is mounted and the cable is attached to it leaving at least six inches to work with (see Figure B).

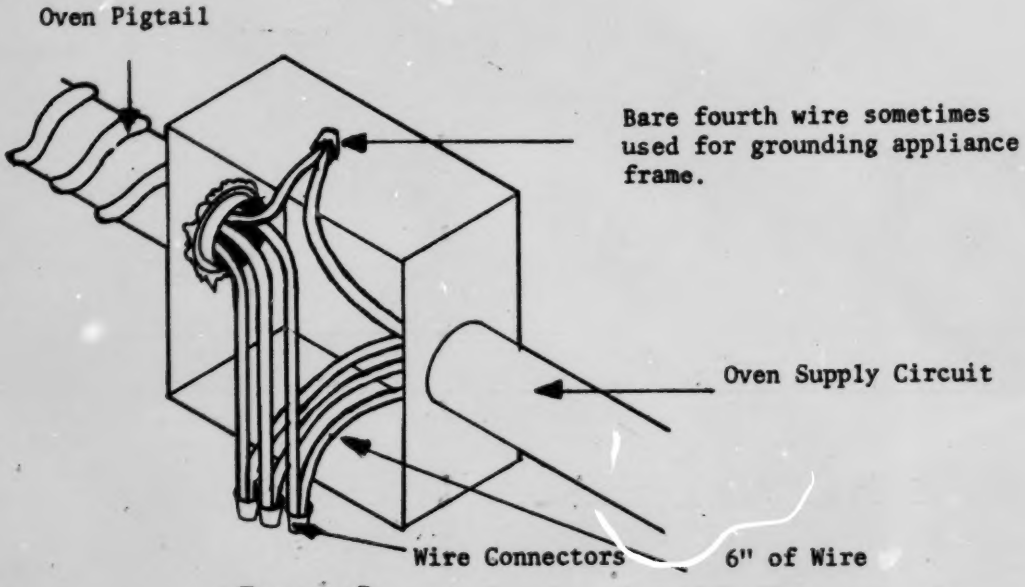



FIGURE B
"J" Box for Electric Oven

Most ovens come with an armoured pigtail lead which is attached to the "J" box also, allowing approximately six inches of wire for connection to the feeder cable.

The service panel end of the cable is prepared and connected to the circuit breaker(s) and neutral bus (see Figure C).

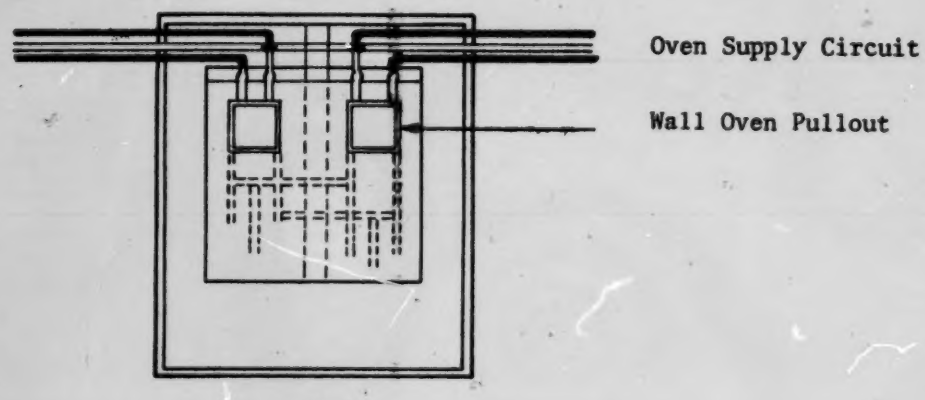



FIGURE C
Service Panel, Oven Connection

1. Record information from the oven to be installed in table A below.
2. Consult National Electric Code (NEC) for minimum wiring requirements and calculate information for Table B.
3. Make a list of materials needed to wire circuit and show this list to the instructor.
4. Secure materials from storeroom.
5. Go to wiring panel and wire complete circuit for oven.
6. Have instructor check your work.

Table A

Oven to be installed:

Model _____

Serial#_____

KW_____ (120/240)

KW_____ (110/208)

Table B

A. Size and type of ungrounded wire _____

B. Size and type of grounded wire _____

C. Number of conductors _____

D. Amperage rating of receptacle (is used) _____

E. Type and rating of protection device _____

Uncrate the assigned oven and install in a wall cabinet. Record the serial number of the oven in the space below. Follow the installation outlined on this page.

Oven Serial Number_____

Installation Steps

1. Uncrate oven.
2. Check for shipping damage.
3. Remove all packing material inside and out.
4. Measure the cabinet.
5. Install pigtail and prepare ends for splicing.
6. Install box connector.
7. Splice the wiring.
8. Place cover on box.
9. Slide oven in being careful not to mar cabinet.
10. Check operation of oven.
    a. preheat
    b. thermostat
    c. clock
    d. light
11. Fasten oven to cabinet.
12. Check with instructor.

The instructor will play the role of the customer. The student will explain the following.

1. Instruct the customer on how to set the controls for baking.

    a. Preheating instructions.
    b. Cooking instructions.

2. Instruct the customer on how to set the oven for broiling.

    a. Selector setting.
    b. Thermostat setting.
    c. Opening door to broil stop.

3. Instruct the customer on how to set the oven for timed cooking.

    a. Setting the timer.
    b. Setting the selector switch.
    c. Thermostat setting.

4. Instruct the customer on how to set the oven for cleaning.

    a. Timer set up.
    b. Selector switch setting.
    c. Thermostat setting.
    d. Removing racks.
    e. Locking the door.
    f. Covering glass in door if necessary.

All of the above instructions should be done following the operating instructions that come with the oven being installed.

**MAJOR BLOCK** Major Appliances **NAME** _____

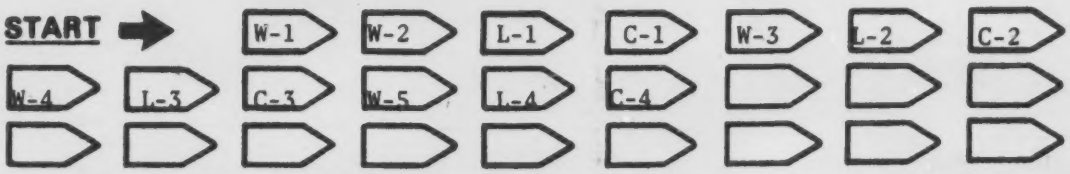
**TASK** Installing Appliances

**UNIT** Installing Surface Unit and Hood **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-03

**OBJECTIVE(S)**

Install and wire a surface range unit and exhaust hood.




**WRITTEN ASSIGNMENT(S)**

| | |
|---|---|
| W-1 | Assignment Sheet MA-03a |
| W-2 | Information Sheet MA-03a |
| W-3 | Information Sheet MA-03b |
| W-4 | Information Sheet MA-03c |
| W-5 | Information Sheet MA-03d |
| W-6 | |
| W-7 | |

**AUDIOVISUAL(S)**

| | |
|---|---|
| A-1 | |
| A-2 | |
| A-3 | |
| A-4 | |
| A-5 | |
| A-6 | |
| A-7 | |

**LABORATORY ASSIGNMENT(S)**

| | |
|---|---|
| L-1 | Job Sheet MA-03a |
| L-2 | Job Sheet MA-03b |
| L-3 | Job Sheet MA-03c |
| L-4 | Job Sheet MA-03d |
| L-5 | |
| L-6 | |
| L-7 | |
| L-8 | |
| L-9 | |

**CHECKPOINT(S)**

| | |
|---|---|
| C-1 | Instructor Check |
| C-2 | Instructor Check |
| C-3 | Instructor Check |
| C-4 | Instructor Check |
| C-5 | |
| C-6 | |
| C-7 | |
| C-8 | |
| C-9 | |

Prepare for installing a countertop cooking unit and exhaust vent by computing the needed wire sizes and branch circuit protection devices. Use the following National Electric Code articles as an aid:

| | | |
|---|---|---|
| 422-17 | 220-19 | 210-19 |
| 210-22 | 220-10A | 220-30 |
| 250-60 | 220-19 | 210-7 |
| 210-23 | 422-17 | 250-57 |
| 422-16 | | |

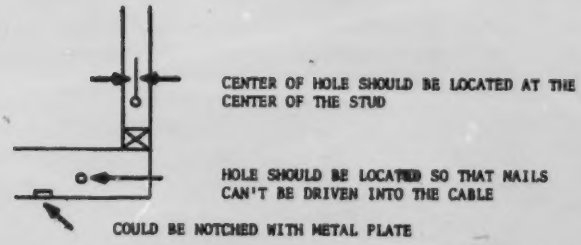
Describe wire sizes and types needed:

Describe the types and sizes of branch circuit protection devices:

## Installing Cook Tops

After having computed the wire size and the branch circuit protection device, the next step is to measure for running wire. After measuring the wire, layout for drilling holes in studs or joists (Figure A), drill the holes and pull the cable through from the installation site to the service panel. Install the box and put the wire into the box. Prepare the ends of the cable for splicing (Figure B). The other end of the cable should be prepared and connected to the circuit breaker or fuses and the neutral buss (Figure C).

FIGURE A


CENTER OF HOLE SHOULD BE LOCATED AT THE CENTER OF THE STUD
HOLE SHOULD BE LOCATED SO THAT NAILS CAN'T BE DRIVEN INTO THE CABLE
COULD BE NOTCHED WITH METAL PLATE

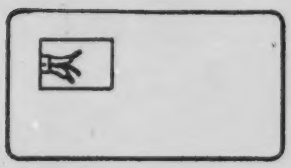


FIGURE B

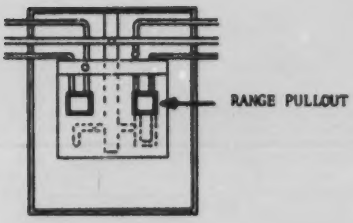



FIGURE C

Installing Cook Tops

Ask the instructor to assign a work area to run the wire for a cook top.

Installing Cook Tops

Remove the cook top from the box, measure it and the cabinet cutout to make sure the unit will fit. Next, prepare the ends of the pigtail wires for splicing. Connect an A/C box connector to the armored cable and install it into the junction box. Make wiring connections in approved methods and insulate the splices. Set the cook top into the cabinet cutout and attach it according to the manufacturer's instructions.

## Installing Cook Tops

Go to the instructor and ask to be assigned to a cook top to install and check operation . Use the following standardized steps to assist in completing this job.

A. Remove the unit from the box and

B. Measure the unit

C. Measure the counter cutout

D. If the cutout is the correct size, pull pig tail into the cabinet.

E. Install A/C box connector onto the armored cable.

F. Install the cable into the box.

G. Make the electrical connections according to code regulations.

H. Place the cover onto the box.

I. After attaching the unit to the counter top remove the shipping restraints.

J. Turn all the cooking unit controls off.

K. Turn on the power to the unit at the service panel

L. Turn on each control to highest setting.

M. When the units turn red, set the control to a lower setting.

N. The units should cool down showing that the controls are controlling the units properly.

NOTE: As stated above, these are standardized steps which may be followed in most countertop cooking unit installations. The instructor may have specific installation instructions for the unit assigned for this job sheet.

Installing Exhaust Hood

The hood does not have to be on a separate circuit. The load calculation has to be done with an entire circuit when the circuit has other outlets on it. Figure out the wattage rating for the hood and the other items on the circuit. The total has to be 80% or less of the value of the current rating of the protection device.

After the circuit has been chosen, find a convenient junction box on that circuit for splicing into the circuit. After a junction box has been chosen, run the wire from the installation site to the junction box, turn off the power to the circuit and make the splices. On the other end prepare the wire for hooking up to the hood.

Installing Exhaust Hood

Go to the instructor and ask to be assigned to a work area to run the circuit for an exhaust hood. Next, run the circuit using the guidelines in Information Sheet MA-03c.

Installing Exhaust Hood

Remove the hood from the box and carefully read the instructions for installation. Measure the area in the cabinet to make sure the hood will fit. Following the instructions, cut the necessary holes in the ceiling and roof, if it is a vented hood. Install the exhaust hood and attach the duct for the vent and then put the flashing and roof vent in place. Make sure the flashing is sealed around the edges to prevent leaks.

After the hood is in place, find the junction box mounted on the hood and remove the knockout. Install a cable connector on the cable run in the previous job and install it into the junction box on the hood. Make the wiring connections and put the cover on the box.

The ventless hood is installed in the same manner, except no holes are required for the duct because there is no duct.

Range hoods come in sizes ranging from approximately 24 inches to approximately 48 inches. They may be installed under cabinets in which case they are mounted directly to the cabinet or special wall brackets may be obtained and used in mounting situations where cabinets are not present. When installing a range hood the manufacturers directions must be followed. They will give alternative directions to use with the specific hood being installed which will allow it to be used in many different applications.

Installing Exhaust Hood

Ask the instructor to assign a vent hood to install. Use Information Sheet MA-03d and the guidelines below as a guide in the installation procedure.

NOTE: The manufacturer's directions should be followed in the installation procedure if they are available. If not, the following outline will serve as a standard procedure which may be followed:

A. Remove the exhaust hood from the box.

B. Measure the unit and the space to be installed.

C. Lay out the holes for the vent duct in the ceiling and the roof, as per directions in the instructions for the exhaust hood.

D. Locate the junction box on the hood and remove the box cover and the knock out as per directions for the hood.

E. Install a cable connector to the cable.

F. Remove the cover from the junction box. The box will be behind the filter element or the light cover.

G. When lifting the hood into position, feed the wires into the junction box.

H. Attach the hood following the instructions with the hood, if they are available.

I. Once the hood is in place, mount the cable connector to the junction box.

J. Prepare the ends of the wires for splicing.

K. Make splices. Make sure to connect the white (wires) to white and black to black.

L. Attach the grounding wire to the hood frame.

M. If installing a ventless hood, the instructions will be the same as for the vented hood, except that the duct is not used, and no holes will be cut.

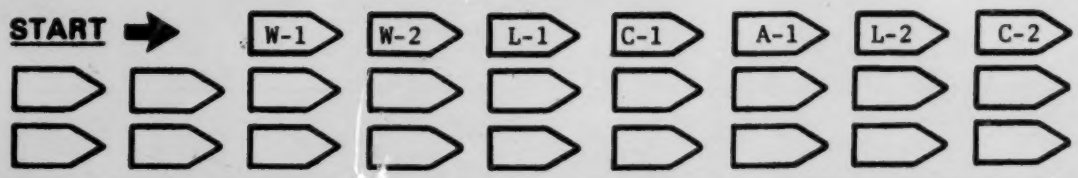
**MAJOR BLOCK** Major Appliances **NAME** _____

**TASK** Installation of Appliances

**UNIT** Installing Dryers **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-04

**OBJECTIVE(S)** Install an automatic clothes dryer




**WRITTEN ASSIGNMENT(S)**

W-1 Information Sheet MA-04a
W-2 Information Sheet MA-04b
W-3 _____
W-4 _____
W-5 _____
W-6 _____
W-7 _____

**AUDIOVISUAL(S)**

A-1 _____
A-2 _____
A-3 _____
A-4 _____
A-5 _____
A-6 _____
A-7 _____

**LABORATORY ASSIGNMENT(S)**

L-1 Job Sheet MA-04a
L-2 Job Sheet MA-04b
L-3 _____
L-4 _____
L-5 _____
L-6 _____
L-7 _____
L-8 _____
L-9 _____

**CHECKPOINT(S)**

C-1 Instructor Check
C-2 Instructor Check
C-3 _____
C-4 _____
C-5 _____
C-6 _____
C-7 _____
C-8 _____
C-9 _____

# Installation of an Electric Dryer

Installation of an electric dryer involves:

1) Determining the electrical requirements and making electrical connections
2) Determining location of the machine
3) Installation of the machine
4) Informing the customer about care and use of the machine.
   In some installations, where there is no provision for venting the dryer, the technician will have to install duct work to vent the dryer. Venting will be discussed in another information sheet.

## Determining Electrical Requirements

The service technician preparing to install an electric dryer should first, prior to set-up, determine the electrical requirements for the machine. This is done by reading the RATING PLATE (located inside the dryer door in most cases). The dryer should be on its own circuit and will have one of the following voltage frequency and fusing requirments:

| | | |
|---|---|---|
| 120/240v | 3-wire | 30 amp. |
| 120/208v | 3-wire | 30 amp. |
| 120v | 2-wire | 20 amp. |

## Set-up of the Machine

Some dryers are not approved for installation in a closet or alcove, therefore, check the dryer installation instructions. In a closet or alcove installation make sure of the following conditions:

1. The unit must be vented outdoors
2. There should be at least 3 inches clearance in the front and back (zero on the sides)
3. Closet doors should be vented or louvered, providing 60 square inches of ventilation for the dryer, (and 60 square inches more for a washer).

## Crate Removal

Many dryers are attached to a wooden crate for shipping purposes. In most cases, the wooden slats are attached with the leveling legs. These should be removed and saved for the leveling procedure.

## Leveling

Screw the leveling legs back on the dryer. Secure them with jam nuts provided with the machine. The legs should extend 1/2 inch below the bottom of the dryer. Return the dryer to the upright position and with a leveling device make sure the dryer is in a level position. The leveling legs may be screwed in or out as needed.

## Venting

Most dryers are vented to the outdoors to prevent lint, moisture and excess heat from building up in the house. It is possible to install a special device on the dryer vent which will catch the discharged lint, and express the exhaust heat into the house. This heat can be used to warm the house, however, caution should be taken to insure a proper installation. Always thoroughly read any installation instructions, and investigate the advantages and disadvantages.

When venting the following do's and don'ts should be a guide:

| DO | DON'T |
|---|---|
| Exhause the dryer to the outside (except in special cases) | Exceed the maximum Allowed duct work |
| Use short lengths of vent pipe and as few turns as possible. | Exhaust into a chimney, the attic or under an enclosed floor |
| Use rigid metal duct work | Exceed 8 feet of duct |
| Use a dampered wall cap | |
| Inspect and clean at established intervals | |
| Seal all joints | |

NOTE: Use the dryer manufacturer's instructions for proper duct work installation.

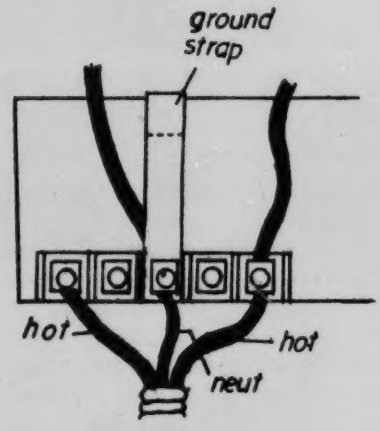
## Electrical Connections

There are three basic methods for making an electrical connection to a dryer: 1) a 208v or 240v. three wire connection. 2) a 208v or 240v. four wire connection or 3) a 120v. connection.

208v./240v. connection (three wire):

1. Remove the electrical access plate
2. Connect two hot lines to the two outer (usually brass colored) studs
3. Connect neutral line to center (usually silver colored) stud. Also, connect the ground strap to this stud.
4. Another grounding method is to connect grounding screw on cabinet to a cold water pipe or other ground (see Figure A).

FIGURE A



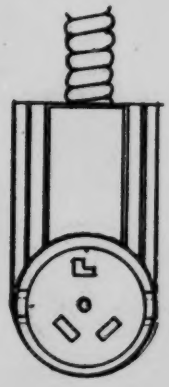



FIGURE B

208v./240v. connection (four wire):

1. Remove the electrical access place
2. Connect the two hot lines to the outer (usually brass colored) studs
3. Connect neutral line to center (usually silver colored) stud
4. Attach ground wire of the power supply to the terminal block. This is normally where the grounding strap (which must be removed) is located.

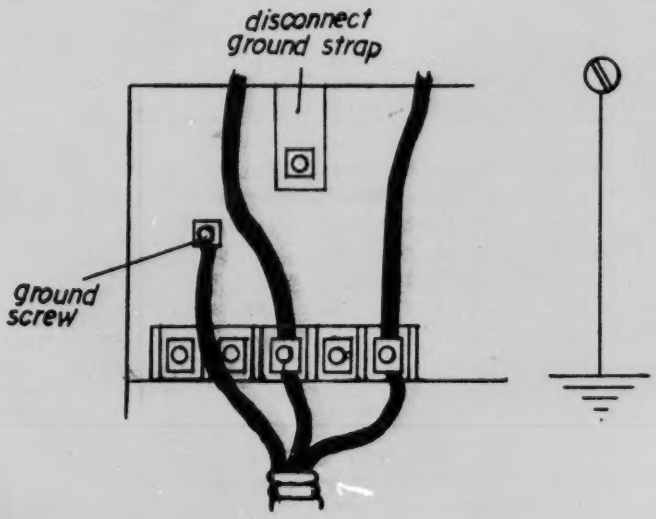



FIGURE C

FIGURE D

120v. connection:

1. Remove access plate
2. Move the internal black wire from an outer hot stud to the center neutral stud.
3. Connect power to the center neutral stud and the outer hot stud
4. Connect the ground wire to the terminal block (after disconnecting the grounding strap

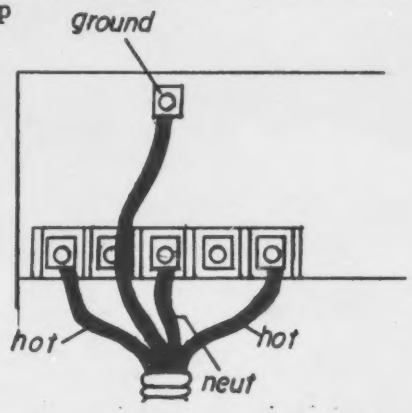
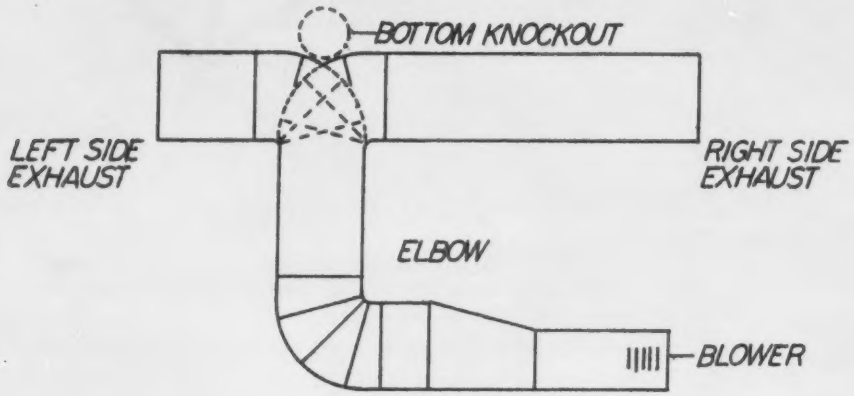



FIGURE E

NOTE: Not all dryers are approved for 120 volts. Check with the manufacturer's instructions for further details. In any case THE APPLIANCE MUST BE PROPERLY GROUNDED.

Most dryers come from the factory with the capability of changing the vent from rear to side or down exhaust. Students should follow these procedures:

1. Remove access panel
2. Remove duct work back to blower outlet
3. Obtain adjustable elbows and straight extentions, knock out bottom or side vent parts and reassemble duct work.



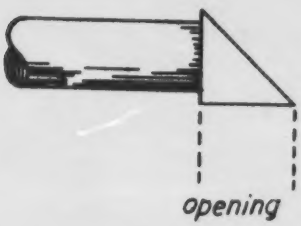

When running rigid duct work, the service technician may run up to 90 feet of exhaust duct. However, the number of 90° elbows will reduce the number of linear feet. The chart below matches linear feet with 90° elbows.

| 90° elbows (separated by at least four feet | Linear feet (rigid duct work) |
|---|---|
| 0 | 90 feet |
| 1 | 70 feet |
| 2 | 60 feet |
| 3 | 50 feet |
| 4 | 40 feet |

NOTE: Manufacturers will recommend exhaust specifications. These should be followed EXACTLY. Improperly exhaust vents can cause a FIRE HAZARD.

When the exhaust vent has been run, a wall cap must be placed on the end to prevent back drafts and entry of foreign matter or animals. The wall cap should not prevent in any manner the flow through the exhaust vent.

Two basic types of wall caps are used to terminate the exhaust vent. Both are illustrated below.



Any exhaust duct work should be sealed with duct tape and if it runs next to an air conditioning vent or an unheated area, it should be insulated (to reduce condensation).

When a nonmetallic duct must be used instead of rigid metal duct work, it should be limited to a maximum of eight feet. This flexible (usually plastic) duct should <u>not</u> be used in the dryer cabinet.

Prevent the flexible duct from collapsing at any point. If necessary, turns may be made with rigid elbows.

See the instructor for assignment to a work area to install a dryer vent. Use the foregoing information sheets as an aid in the installation procedure.

Note: The dryer vent will be installed as Job Sheet MA-04b

See the instructor for assignment to a work area to install a dryer vent.

The following tools will be needed:

Hole saw

Sabre saw

Key hole saw

Hammer

Chisel

SAFETY GLASSES

Presented below is a standard procedure for making the vent hole. In addition, if manufacturer's directions are available they should be followed.

1. In a wooden wall, cut a four inch hole with the hole saw after determining the correct location. (Caution: most walls are supported by studs placed on sixteen inch centers. Studs may be found by measuring from a known stud, or by tapping on the wall).
2. When the proper location has been determined, find the center of the hole, place the pilot bit at this point and start the drill. When the hole is through one side, carefully align the saw so the hole in the other side of the wall aligns with the first.
3. Another method of cutting the hole is with a sabre saw. After the correct location is found, use the collar to mark the hole to correct size. Drill a hole in the wall and insert the sabre saw blade and begin to make the cut. Once the hole inside is cut, move to the outside and cut the outer wall in the same manner. Remember to align the holes.

4. Still another method of cutting the hole is with a sabre saw. Use a drill bit to drill a hole and insert the blade tip and begin cutting.
5. On a masonry wall, a hammer and chisel must be used. Lay out the hole, take a masonry bit and drill holes around the circumference and finish the hole with the chisel.

**MAJOR BLOCK** Major Appliance **NAME** _____

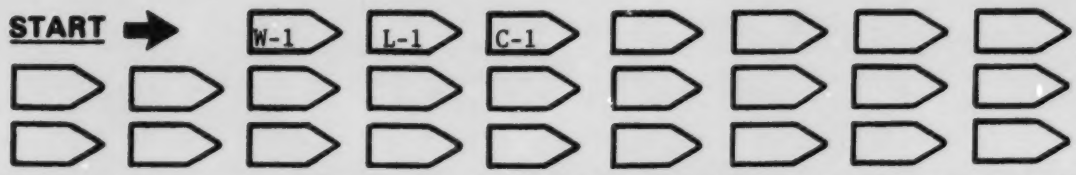
**TASK** Installation of Appliances

**UNIT** Installing Washing Machines **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-05

**OBJECTIVE(S)**

Install an automatic washing machine.




**WRITTEN ASSIGNMENT(S)**

| | |
|---|---|
| W-1 | Information Sheet MA-05a |
| W-2 | |
| W-3 | |
| W-4 | |
| W-5 | |
| W-6 | |
| W-7 | |

**AUDIOVISUAL(S)**

| | |
|---|---|
| A-1 | |
| A-2 | |
| A-3 | |
| A-4 | |
| A-5 | |
| A-6 | |
| A-7 | |

**LABORATORY ASSIGNMENT(S)**

| | |
|---|---|
| L-1 | Job Sheet MA-05a |
| L-2 | |
| L-3 | |
| L-4 | |
| L-5 | |
| L-6 | |
| L-7 | |
| L-8 | |
| L-9 | |

**CHECKPOINT(S)**

| | |
|---|---|
| C-1 | Instructor Check |
| C-2 | |
| C-3 | |
| C-4 | |
| C-5 | |
| C-6 | |
| C-7 | |
| C-8 | |
| C-9 | |

The installation of an automatic washer is a relatively simple process. There are, however, some special techniques which will make the procedure go much more smoothly. This information sheet will outline a basic procedure which may be used when installing most types of automatic washers.

First, be extremely careful when transporting a new washer either on the hand truck or in the delivery vehicle. Measure all doors through which the washer must pass. Be careful when passing through doorways not to damage either the washer or the doorfacing. If possible, leave the carton on the machine until it is ready for transporting.

Take care when removing the carton at the installation site. Most manufacturers have carton removal instructions printed on the side. (In fact, all manufacturers will provide detailed installation instructions which should be followed in detail.) After carton removal, gather all the installation parts from inside the washer.

After the machine has been removed from the carton, lay it on its front and install the leveling feet. On some machines, the front feet are non-movable while the rear feet act as automatic levelers. Follow the manufacturer's recommendations as to the proper installation procedure.

Next, take off the rear service panel from the machine and remove all shipping blocks found inside. These blocks are usually made of styrofoam and prevent internal machine damage during shipping.

The water inlet and drain hoses must be installed while the machine is laying on its front. The inlet hoses screw on similar to a common garden hose. However, make sure the hose connection has a rubber washer (also like a garden hose washer) and give the hose connection an extra half-turn with pliers after tightening by hand. Make sure not to cross thread or to over-tighten.

The water drain outlet is usually found protruding from the bottom of the machine. The outlet hose is connected to the drain outlet with a standard hose clamp (either screw tightening or spring loaded clamps will suffice.) For shipping purposes, the drain outlet remains inside the machine's cabinet to prevent damage. It must be pushed through the hole provided and locked into place.

Raise the machine into an upright position and lift the machine's top cover to remove additional shipping blocks. A putty knife may be used to release the locking clips located between the top and the cabinet.

The machine should now be ready to attach to an electrical connection, to a water source, and to a drain. When preparing to connect to the water source, make sure to connect hot and cold water inlets properly (they should be marked on the back of the machine cabinet). The water inlet hoses should have screens which attach to the hot and cold inlets. A good practice

prior to connecting the inlets is to run a small amount of water through the faucet before making the connection. This will remove any foreign matter which may have collected in the pipe and it will provide a double-check as to which faucet is hot and which is cold. The drain pipe is then inserted into the standing drain outlet.

When water connections have been made, plug the machine into a standard three prong receptacle. The machine must be grounded. This is accomplished through the grounding plug; therefore, if a three prong receptacle is not provided, one must be installed.

The machine is now ready to be placed into a permanent location. For automatically leveling machines, raise the rear of the machine a few inches and let it settle back down to the floor. Then adjust the front feet as needed. A builder's level may be used in this operation, or, the installer may run a small amount of water into the tub (up to the holes) and use it to achieve a proper level.

At this point, the machine should be ready to go. Inspect for leaks, give the customer operating instructions, clean the machine, and clean the work area.

See the instructor for assignment to a washing machine to install. Use the following standard procedure as a guide to the installation, or, if the manufacturer's installation instructions are available, follow them.

1. The first step in installing an automatic washer is to take it out of the box. Do this by cutting at the bottom and lifting it off. Be careful not to cut too deep.
2. Remove the parts bag from the basket and lay the machine on its front on the two corner supports.
3. Remove the two bolts from the back of the machine which hold the shipping blocks in place.
4. Remove the two plastic shipping blocks. Put in the drain connector and put on the drain hose.
5. Pull down the rear leveling legs and turn them so that the pin goes into the slots in the leveling bar.
6. After the rear legs are set, install the front legs and stand the washer up and raise the top.
7. There should be two styrofoam blocks between the base plate and the cabinet. Remove these.
8. Put the top back down and place the hand trucks on the right hand side of the machine.
9. Place the washer on the inlet hose. The "cone" end of the washer should be pointed toward the faucet.
10. Next, determine which faucet is for hot water. This can be done by putting the other end of the hose in the drain and running some water. This is also a good way to check the drain.
11. Next, install the hoses on the machine and check for leaks; also put the drain hose in the drain.
12. Level the machine by adjusting the front legs and raising the back legs off the floor one or two inches and letting it settle down firmly. This adjusts the self-leveling legs in the rear.
13. Finally, instruct the customer in the operation of the machine and remove all trash such as tape, boxes, packing and parts bags.

**MAJOR BLOCK** Major Appliance **NAME** _____

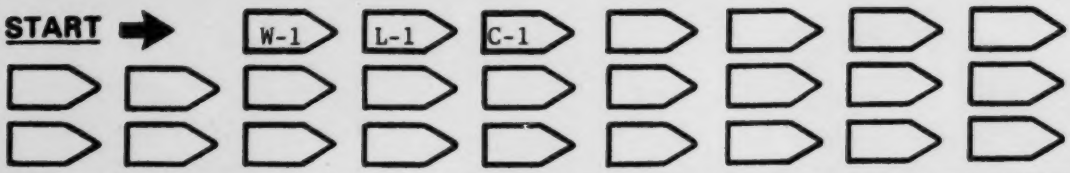
**TASK** Installing Appliance

**UNIT** Installing Dishwashers **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-06

**OBJECTIVE(S)**

Install an undercounter automatic dishwasher.




**WRITTEN ASSIGNMENT(S)**

W-1 Information Sheet MA-06a
W-2 _____
W-3 _____
W-4 _____
W-5 _____
W-6 _____
W-7 _____

**AUDIOVISUAL(S)**

A-1 _____
A-2 _____
A-3 _____
A-4 _____
A-5 _____
A-6 _____
A-7 _____

**LABORATORY ASSIGNMENT(S)**

L-1 Job Sheet MA-06a
L-2 _____
L-3 _____
L-4 _____
L-5 _____
L-6 _____
L-7 _____
L-8 _____
L-9 _____

**CHECKPOINT(S)**

C-1 Instructor Check
C-2 _____
C-3 _____
C-4 _____
C-5 _____
C-6 _____
C-7 _____
C-8 _____
C-9 _____

## Installing Dishwashers

Installation of any appliance should begin with a thorough reading and understanding of the installation instructions which the manufacturer supplies for the unit. Through a careful review of these instructions, needless extra work can be avoided.

Before beginning the job, read the notes on the shipping carton or crate, and follow the instructions for uncrating the unit. After uncrating the unit, gather all of the tools necessary for installation. A list of tools will usually be found in the installation instructions booklet. If the service technician were installing a Kenmore machine, for example, we would find the following list:

1. ¼" electric drill
2. Keyhole saw
3. Phillips-head screw driver
4. Stubby, blade-type screwdriver
5. Two 8" adjustable wrenches
6. ¼" socket set or nutdriver
7. Measuring tape
8. Pipe wrench
9. Pliers
10. Wire stripper or knife.

The following tools may also be needed:

1. 2 pipe wrenches
2. Pipe dope for threads
3. Flaring tool
4. Tube cutter

To begin the job, measurement of the opening in the counter for the dishwasher is important both for the proper fit and operation of the machine and for the appearance of the installation. The installation manual for the machine will give the proper dimensions, but it is generally a wise precautionary step to also measure the machine's cabinet before cutting the counter. After measuring the opening, an important series of decisions must be made concerning hook-up and location of the drain, the water supply, and electrical connections.

### Drain Location

Location of the drain can be done in one of three ways:

1. If there is a garbage disposal in the sink, the drain can be hooked up here with a waste-tee.
2. If there is simply a drain (no disposal), the waste-tee can be installed in the drain.

It is important in options one and two on the previous page to tap the drain or disposal above the trap (Fig. A ).

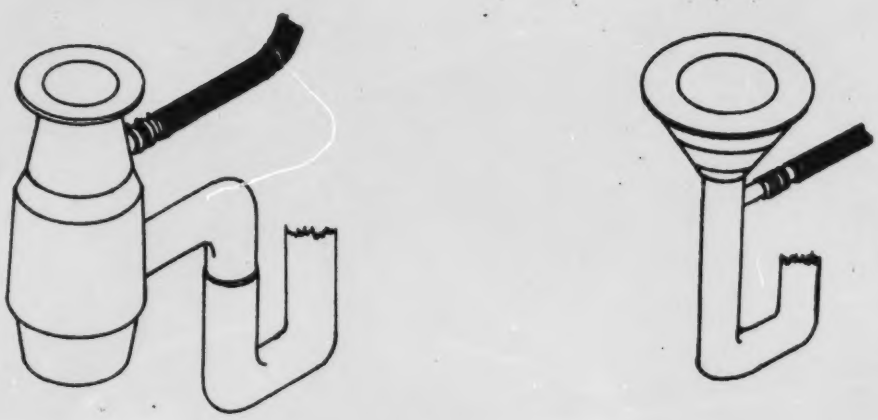


FIGURE A

Where a sink is not available either to the right of left of the dishwasher, or if it is not conveniently located, the third option is to install the drain hose connection through the floor (Fig. B).

FIGURE B

Note that the installation of a drain hose through the floor requires that the trap be vented in order to prevent siphoning.

Hooking Up the Water Supply

Depending upon the location of the dishwasher, the water pipe may have to be routed through the wall, through the floor, or through the cabinet (Fig.C). In either case, it is important that the water pipe be routed straight forward to the inlet valve as shown in Figure C and NOT IN FRONT OF THE MOTOR.

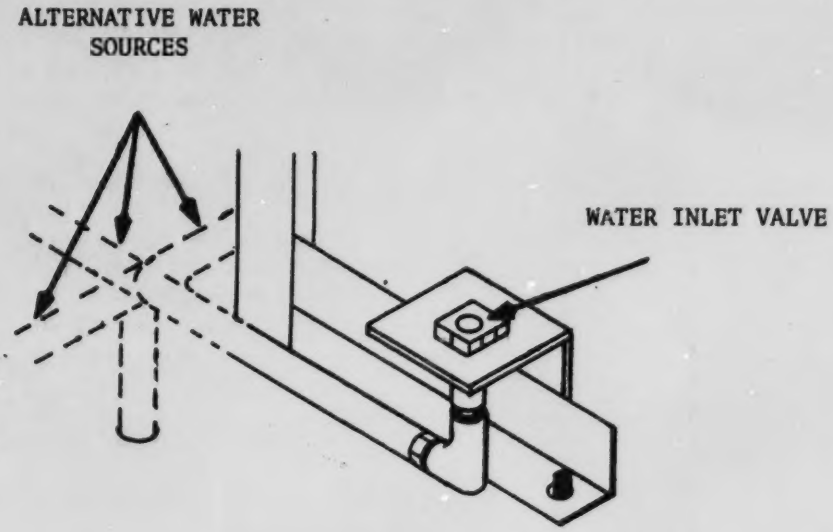



FIGURE C

CAUTION: Piping must not be kinked. It must be free of foreign matter to prevent damage to the machine. These precautions must be taken before connection to the inlet valve.

Electrical Connections for Dishwasher

The first thing to keep in mind when making the electrical connections is that the dishwasher must be permanently grounded in accordance with the National Electrical Code and local codes and ordinances.

Running the wires to the dishwasher may be done in one of three ways. The wiring may be run through the wall, through the cabinet, or through the floor. Once the most convenient electrical source has been tapped, the wiring should be pulled through the dishwasher, being careful not to run it in front of the motor, to the junction box on the machine.

First, remove the screws holding the junction box cover in place and remove the junction box cover. Pull the wiring through the large hole in the junction box plate. Strip the ends of the wires and connect the green grounding wire

to the grounding screw. Run the black and white wires from the dishwasher terminal block through the small hole in the junction box plate and connect these wires to the black and white wires from the power source with wire nuts. Replace the junction box cover.

Methods of Anchoring Cabinet

The dishwasher may be anchored using one of two methods. The first method is counter-top anchoring. This method involves the use of mounting brackets attached to the counter-top and to the dishwasher cabinet as shown in the illustration. The procedure involves four steps:

1. If the counter-top mounting bracket is longer than needed, mark it, remove it, and saw off the excess.

2. Adjust the leveling screws so the mounting brackets touch the underside of the counter top.

3. Screw the mounting bracket to the counter top.

4. Open and close the dishwasher door and make sure that there is no interference with the movement of the door.

Another method of anchoring a dishwasher is to the floor. This method is difficult and should only be used when counter top brackets cannot be used. In some machines, ½" lag screws are used. If the flooring is concrete, expansion fasteners must be used to allow the screws to take hold. When the dishwasher is anchored, replace the toe plate assembly and adjust its location so that it mounts flush with the floor.

Leveling the Dishwasher

To level the dishwasher, move it as necessary for alignment with the front of the cabinets and locate it between the cabinets so that the space on either side is equal. Use a screwdriver to adjust the level of the dishwasher leveling legs so that the unit is aligned with the cabinets. Once it is leveled, the dishwasher can be anchored.

Installation and Operation

Use this guide for a double check of all installation tasks:

1. Make sure the unit is fastened in place.

2. Turn on the water supply valve.

3. Check all joints for leaks.

4. Check all wiring connections to assure that they are tight.

5. Is the electricity on?

6. Are there any kinks in the water or drain lines?

7. Spin the spray arm manually to check for proper movement.

8. Remove customer literature package and explain operation to customer.

9. Start the dishwasher.

10. Check the water level after it has filled. The water level should come up to the heater element.

11. After it has cycled through and drained, make sure that it has drained completely.

12. Check for leaks after the unit has run:

    1. around the door
    2. around pump mounting gaskets
    3. at hose connections

See the instructor for assignment to a dishwasher to install. Use Information Sheet MA-06a and the manufacturer's instructions as a guide.

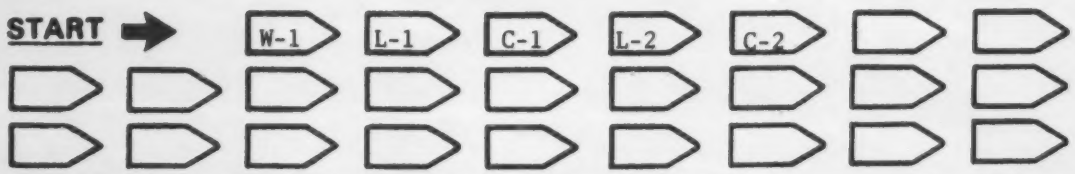
**MAJOR BLOCK** Major Appliance **NAME** _____

**TASK** Installation of Appliance

**UNIT** Installing Garbage Disposals **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-07

**OBJECTIVE(S)** Install and operate a garbage disposal unit.




**WRITTEN ASSIGNMENT(S)**

W-1 Information Sheet MA-07a
W-2 _____
W-3 _____
W-4 _____
W-5 _____
W-6 _____
W-7 _____

**AUDIOVISUAL(S)**

A-1 _____
A-2 _____
A-3 _____
A-4 _____
A-5 _____
A-6 _____
A-7 _____

**LABORATORY ASSIGNMENT(S)**

L-1 Job Sheet MA-07a
L-2 Job Sheet MA-07b
L-3 _____
L-4 _____
L-5 _____
L-6 _____
L-7 _____
L-8 _____
L-9 _____

**CHECKPOINT(S)**

C-1 Instructor Check
C-2 Instructor Check
C-3 _____
C-4 _____
C-5 _____
C-6 _____
C-7 _____
C-8 _____
C-9 _____

Before starting to install the disposer, measure the area under the sink to make sure there is enough room. Also, measurements should be made for drain lines and possibly for electrical installation if necessary.

Once the measurements are completed remove the present sink drain line, strainer, and trap. Then clean off old gaskets and putty to insure a leak-proof seal. After the cleaning is finished remove the sink mounting assembly from the disposer and separate all the parts by prying out the snap ring. Loosen the mounting screws until they are flush with the mounting ring.

If the home is not new it will be a good idea to clean out the drain with a plumbers rod or tape. This will help prevent problems with the drain backing up or stopping up later.

Apply an oil based putty around the drain opening and place the sink sleeve in the opening. Under the sink put the fiber sleeve gasket, back up ring, and mounting ring on the sleeve. Then put the snap ring in the groove. Tighten the three mounting screws evenly and firmly. Attach the discharge tube to the side of the disposer. Lubricate the top surface of the mounting gasket with bar soap and raise the disposer to the mounting ring. Start turning the mounting ring by hand,insert the service wrench and tighten until the lugs lock into position (make sure the discharge lines up with the drain line). Connect the disposer discharge line to the trap and tighten. Check the installation for leaks first by slowly running water through it, then place the stopper into the drain and fill the sink with water and remove the stopper and check for leaks again.

A. Remove the contents from the box and make sure everything is there.

B. Measure under the sink to make sure there will be enough room to install the disposer.

C. Remove the drain line and trap from the sink.

D. Remove the strainer from the sink.

E. Clean the old gaskets and putty from the sink.

F. Remove the sink mounting assembly from the disposer.

G. Pry out the snap ring on the mounting assembly and separate the parts.

H. Apply an oil base putty around the drain opening in the sink.

I. Insert the sink sleeve in the drain opening.

J. Under the sink place the fiber sleeve gasket, back-up ring and mounting ring on the sleeve.

K. Snap the ring into the groove in the sleeve.

L. Tighten the mounting screws evenly and securely.

M. Install the discharge line onto the disposer.

N. Lubricate the mounting gasket with bar soap.

O. Line up the discharge line with the drain line.

P. Raise the disposer and hand tighten the mounting ring.

Q. Using the self-service wrench supplied with the disposer tighten the mounting ring until the lugs lock into the mounting ring over locking tab.

R. Check for leaks by running water through the disposer.

Go to your instructor and explain how to operate the disposer that you just installed.

**MAJOR BLOCK** Major Appliance **NAME** _____

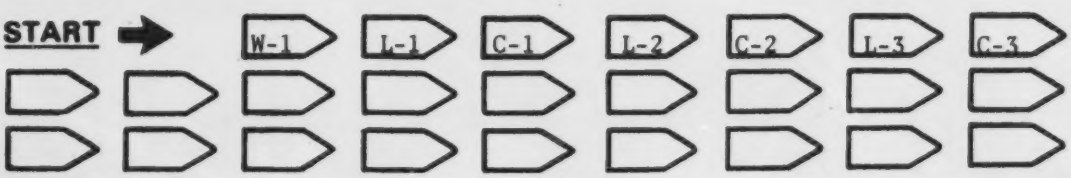
**TASK** Installation of Appliances

**UNIT** Installing Refrigerator and Freezer **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-08

**OBJECTIVE(S)**

Uncrate, service, and install a refrigerator freezer.




**WRITTEN ASSIGNMENT(S)**

**W-1** Information Sheet MA-08a
**W-2** _____
**W-3** _____
**W-4** _____
**W-5** _____
**W-6** _____
**W-7** _____

**AUDIOVISUAL(S)**

**A-1** _____
**A-2** _____
**A-3** _____
**A-4** _____
**A-5** _____
**A-6** _____
**A-7** _____

**LABORATORY ASSIGNMENT(S)**

**L-1** Job Sheet MA-08a
**L-2** Job Sheet MA-08b
**L-3** Job Sheet MA-08c
**L-4** _____
**L-5** _____
**L-6** _____
**L-7** _____
**L-8** _____
**L-9** _____

**CHECKPOINT(S)**

**C-1** Instructor Check
**C-2** Instructor Check
**C-3** Instructor Check
**C-4** _____
**C-5** _____
**C-6** _____
**C-7** _____
**C-8** _____
**C-9** _____

The first step in installing any appliance is to remove the crate or box. Some refrigerator/freezer boxes are folded and banded at the top and bottom. See Fig. A.

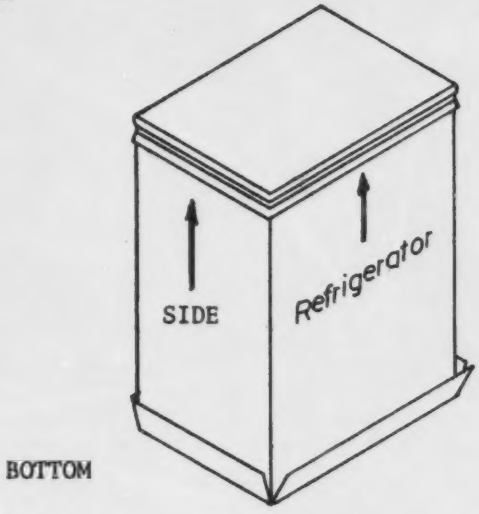



FIGURE A

With this type box, cut the bottom band, unfold the flaps and lift off the box. Tilt the refrigerator to one side and remove the slats bolted to the bottom. Some refrigerator/freezers are mounted on wood frames and the boxes are stapled to the frame. This is the case with most chest type freezers. With this type box cut along the bottom of the box. There will usually be a dotted line around the bottom for this purpose. See Fig. B.

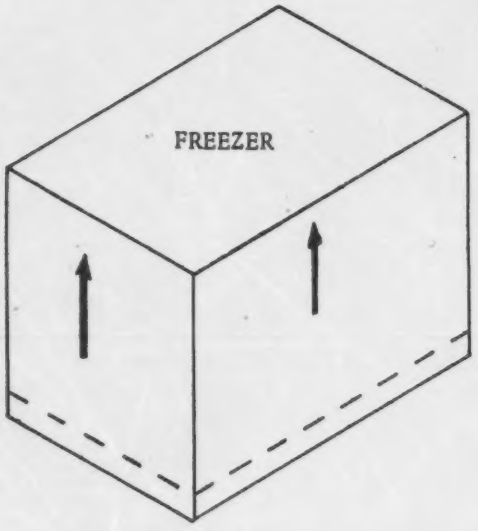



FIGURE B

Once the box is removed raise one end and remove the bolts holding the wood frame to the bottom, then do the other end. A 2" x 4" block would be handy for this purpose.

Chest type freezers normally do not have leveling legs. When necessary use blocks or wedges to get the cabinet level or sitting firmly on the floor. Refrigerators and upright freezers will usually have only two leveling legs which are to be installed on the front cross rail. When leveling adjust the legs so that when the door is opened about half-way the door will not move. See Fig. C.

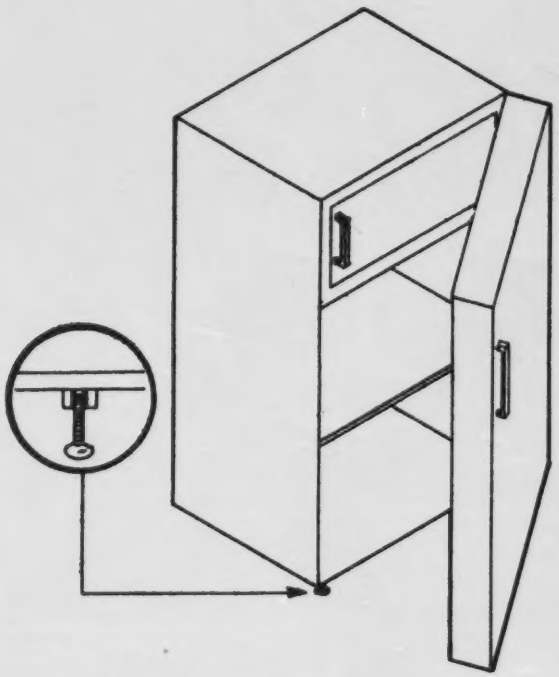


FIGURE C

Some models are equipped with casters. On these models the leveling legs should be adjusted to raise the front casters off the floor to prevent the refrigerator from rolling.

When putting the refrigerator or upright freezer in place if equipped with a static condenser there must be a 1" clearance behind and 3" clearance at the top of the cabinet. When a fan cooled condenser is used there does not have to be any top or back clearance, but there should be a half-inch

clearance at the sides because movement of the cabinet can beat the finish off the cabinet. A half-inch clearance also provides for ease in moving for cleaning and service.

Once the appliance is in place check the door or doors for sealing. If there is no seal from top to bottom this can be adjusted by twisting. See Fig. D.

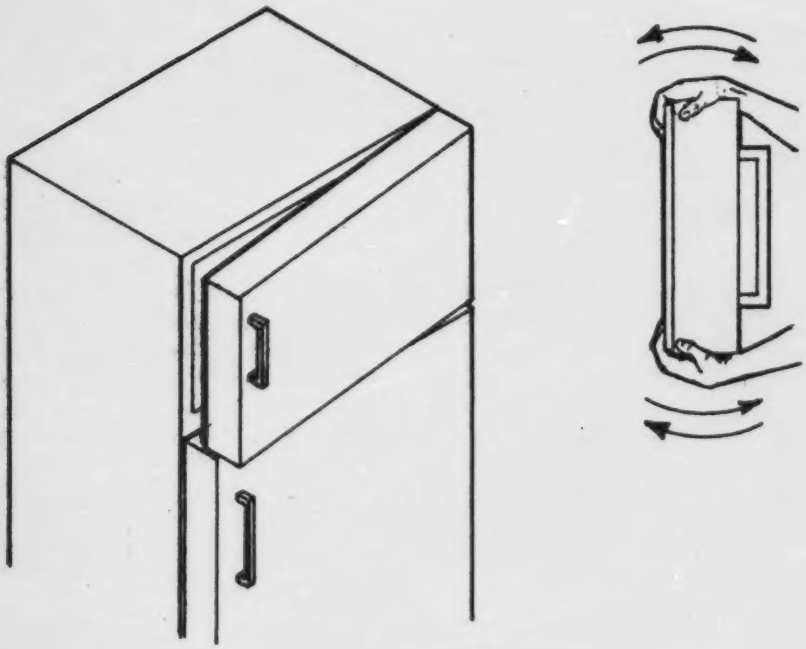


FIGURE D

The final step is to remove packing material from inside of the cabinet.

See the instructor for assignment to a refrigerator or freezer to install. The following is a standard procedure which may be used in the installation of most refrigerators and freezers:

A. Cut band at bottom of box.

B. Unfold flaps

C. Lift off box

D. Remove skids from the bottom of the refrigerator

E. On chest type freezers cut bottom of box on dotted line.

F. Lift end of freezer and remove the bolts holding wood frame to cabinet.

G. On refrigerator and upright freezers install the leveling legs on the front cross rail.

H. Put refrigerator in position and check clearances. 1" back - 3" top on models with static condenser no clearance is needed with models with fan cooled condensers. All should have ½" side clearance to prevent damage to finish.

I. Adjust the leveling legs so that when the door is opened about half-way the door will remain open and will not open any further when you let go of the door.

J. Check the door for sealing if one corner is standing out.

K. Loosen screws and grasp door and twist until the door will close all the way.

L. Remove the packing and plug in the refrigerator.

M. Some models have reversible doors; that is, the door can be changed to swing open in the opposite direction. If the doors are reversible cabinet will have pre-taped screw holes. When doing this remove the top door first by removing the top hinge.

N. Next remove the middle hinge.

O. While the doors are off reverse the handles first, remove the covers hiding the screws (they have to be pried off), then remove the screws.

P. Remove the plugs or screws on the other side of the door and put them in the old holes.

Q. Remove the bottom hinge and put it on the other side of the cabinet and change the pin to the left side of the plate.

R. Remove all plugs and put on the right side of the cabinet. Put the hinges and the door on the left side.

1. Ask the instructor to assign an icemaker to install.

2. The following instructions are basic to most types of ice maker installations. Refer to them and the manufacturer's instructions when installing the ice maker for this job.

   A. When installing an ice maker the following tools will be needed: (1) drill motor, (2) 5/32" drill bit, (3) ½" open end wrench, (4) 7/16" open end wrench, (5) slotted screwdriver, (6) 7/16" wood boring kit.

   B. Select the site for the valve to be installed. The cold water line going to the kitchen sink is ideal. The site chosen should be easily reached in case of an emergency.

   C. In case of a steel pipe turn off the water supply and drain the pressure off of that line by opening a faucet.

   D. Drill a 5/32" hole in the cold water supply line. Anywhere will do on a vertical run. On a horizontal run put hole in top or side of pipe but never in the bottom.

   E. After the hole is drilled put the valve on the saddle clamp and install the rubber washer. The needle should extend 3/16" beyond the rubber gasket.

   F. Place the needle in the hole and assemble the clamp and tighten it down.

   G. If installing on a copper line assemble the clamp around the line with the needle flush with the bottom of the gasket.

   H. When tightening the clamp tighten screws evenly and firmly. This should be enough to pierce the tubing.

   I. If the tubing must be run through the floor or the cabinets drill the holes using a wood boring bit or a 5/16" twist bit.

   J. Run ¼" O.D. copper tubing from the refrigerator to the water valve.

   K. Leave about 4 feet coiled behind the refrigerator so if needed, the refrigerator can be moved for cleaning or servicing.

   L. Put the compression nut and ferrel on the tubing and insert the tubing into the valve and tighten.

   M. Using a bucket or a pan run some water through the tubing.

   N. Hook the tubing to the back of the refrigerator using two nuts, two ferrels, and a union supplied with the refrigerator.

   O. Turn on the saddle valve and check for leaks.

NOTE: The above instructions may not apply to all types of installations. In addition, local plumbing codes must be observed.

Act as if the instructor or another student is the customer and explain the operation of the refrigerator and/or freezer with the ice maker.

**MAJOR BLOCK** Major Appliance **NAME** _____

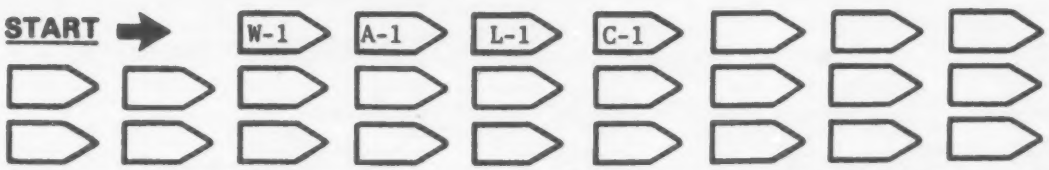
**TASK** Installation of Appliances

**UNIT** Transporting Major Appliances **TIME (est.)** _____ **(act.)** _____

**UNIT NO.** MA-09

**OBJECTIVE(S)**

Use the hand truck to move heavy appliances.




**WRITTEN ASSIGNMENT(S)**

W-1 Information Sheet MA-09a
W-2
W-3
W-4
W-5
W-6
W-7

**AUDIOVISUAL(S)**

A-1 Slide Set MA-09a
A-2
A-3
A-4
A-5
A-6
A-7

**LABORATORY ASSIGNMENT(S)**

L-1 Job Sheet MA-09a
L-2
L-3
L-4
L-5
L-6
L-7
L-8
L-9

**CHECKPOINT(S)**

C-1 Instructor Check
C-2
C-3
C-4
C-5
C-6
C-7
C-8
C-9

Before using the hand truck inspect to see if the belt, wheels and the rollers are all in good shape. The correct procedure for mounting the hand truck on an appliance is (A) tilt the appliance and slide the hand truck under the edge, (B) put the strap around the appliance, (C) tighten the straps. This procedure is as shown in Figures A, B and C.

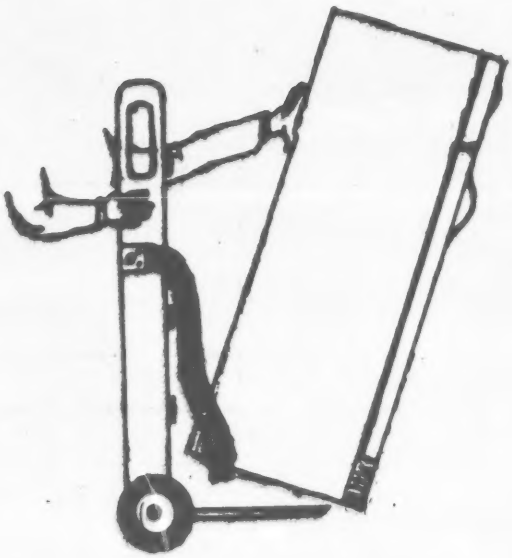


FIGURE A

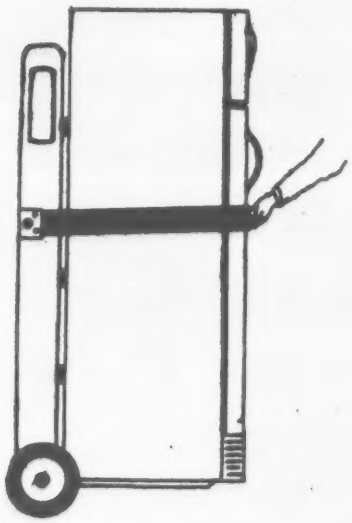


FIGURE B

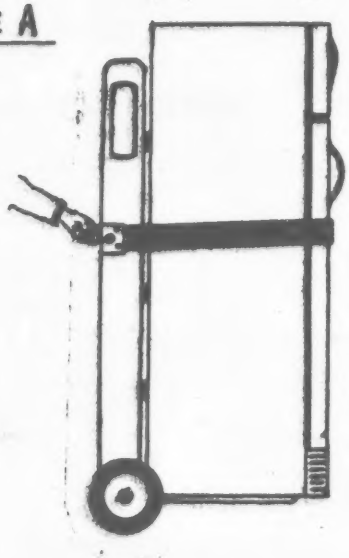


FIGURE C

When using the hand truck be sure the weight is balanced so that the hand truck is doing the work. The weight of the appliance should be on the truck wheels and not the person. Figure D shows the approximate position for this.

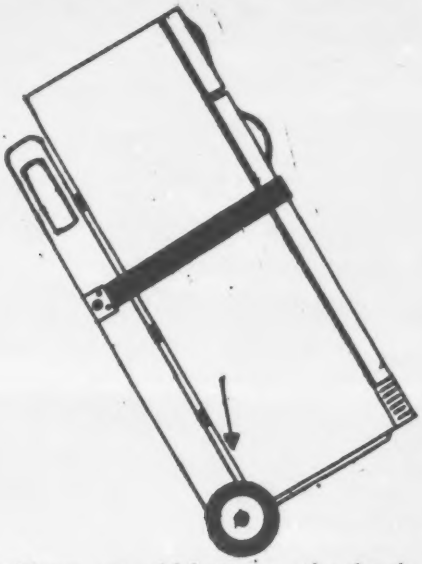


FIGURE D

The hand truck has rollers or gliders on the back rails to facilitate moving an appliance up or down steps as shown in Figure E.

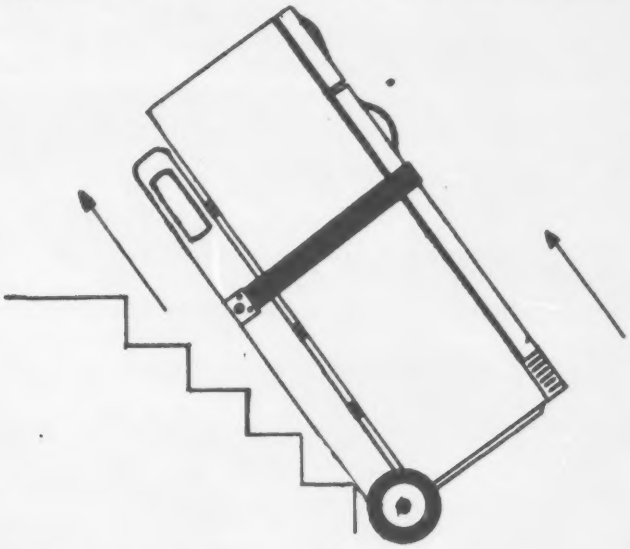


FIGURE E

The instructor will assign an appliance to move with the hand truck.

1. Check the hand trucks to ensure that all straps and accessories are operational.
2. Mount the hand trucks to the appliance and lift it from the floor.
3. Move the appliance on a level surface.
4. Move the appliance down steps.
5. Move the appliance up steps.

**MAJOR BLOCK** Major Appliances **NAME** _____

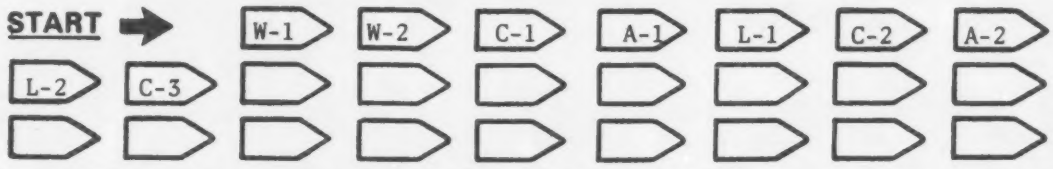
**TASK** Troubleshooting Washing Machine

**UNIT** Total Washing Machine Operation **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-10

**OBJECTIVE(S)**

Identify, remove, and replace all components in a washing machine.




**WRITTEN ASSIGNMENT(S)**

| | |
|---|---|
| W-1 | Information Sheet MA-10a |
| W-2 | Assignment Sheet MA-10a |
| W-3 | |
| W-4 | |
| W-5 | |
| W-6 | |
| W-7 | |

**AUDIOVISUAL(S)**

| | |
|---|---|
| A-1 | Slide/Script MA-10a |
| A-2 | Slide/Script MA-10b |
| A-3 | |
| A-4 | |
| A-5 | |
| A-6 | |
| A-7 | |

**LABORATORY ASSIGNMENT(S)**

| | |
|---|---|
| L-1 | Job Sheet MA-10a |
| L-2 | Job Sheet MA-10b |
| L-3 | |
| L-4 | |
| L-5 | |
| L-6 | |
| L-7 | |
| L-8 | |
| L-9 | |

**CHECKPOINT(S)**

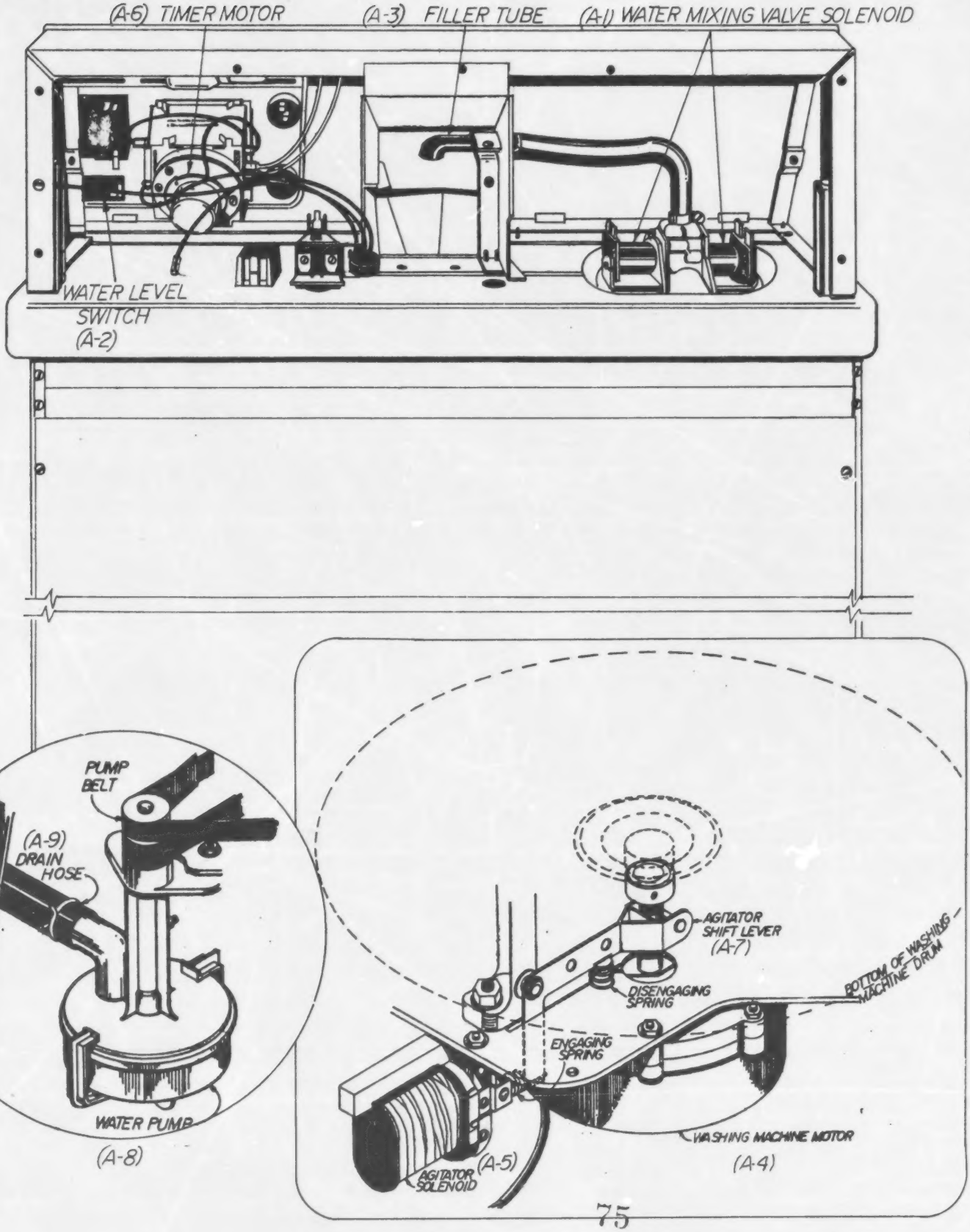
| | |
|---|---|
| C-1 | Instructor Check |
| C-2 | Instructor Check |
| C-3 | Instructor Check |
| C-4 | |
| C-5 | |
| C-6 | |
| C-7 | |
| C-8 | |
| C-9 | |

Total Machine Operation

This information sheet will deal mainly with the operation of a Kenmore Washer. Most other machines will operate similarly, but when differences in operation arise those differences will be put in parenthesis. As the following paragraph is read, refer to Figure A to trace the events.

Starting with the first increment of the normal wash, the mixing valve (A-1) is energized through the water level switch (A-2) causing the water to flow through the valve filler tube (A-3) and into the tub. As the water level rises it traps air in the air dome compressing it and this in turn activates the water level control which starts the motor (A-4) and energizes the agitate solenoid (A-5) and timer motor (A-6) (on most other machines there is no agitate solenoid and the motor turns in a clock wise direction to accomplish the agitate cycle). If a detergent dispenser is used the solenoid controlling it is energized allowing water to flow through and flush out the detergent. Toward the end of the washing cycle the bleach dispenser is opened allowing the bleach to enter near the bottom of the tub. After the bleach has been added, the machine washes for two more increments. The agitate solenoid is then de-energized, pulling the cam bar (A-7) back and causing the pump (A-8) to re-direct the water out the drain (A-9). (On most other machines, when the machine has reached the end of the wash there is a pause for one timer increment, the motor reverses direction and the water is pumped out as the machine begins to spin). Once the water level drops enough to reset the water level switch, the spin solenoid is energized pulling the cam bar back allowing the clutch pads to come in contact with the pulley and the machine begins to spin. For the first increment of spin there is an occasional spray rinse.

# FIGURE A


(A-6) TIMER MOTOR
(A-3) FILLER TUBE
(A-1) WATER MIXING VALVE SOLENOID
WATER LEVEL SWITCH (A-2)
PUMP BELT
(A-9) DRAIN HOSE
WATER PUMP
(A-8)
AGITATOR SHIFT LEVER (A-7)
DISENGAGING SPRING
ENGAGING SPRING
BOTTOM OF WASHING MACHINE DRUM
WASHING MACHINE MOTOR
(A-4)
AGITATOR SOLENOID
(A-5)

**Match the following parts with their function (what the part does), use Information Sheet MA-12a and available shop manuals.**

| PART | FUNCTION |
|---|---|
| 1. ____ Mixing Valve | (A) A syncronized motor that automatically controls various cycles the washer performs |
| 2. ____ Water Level Switch | (B) Controls flow and temperature water entering the machine. |
| 3. ____ Filler Tube | (C) The main drive motor that performs the major word of the machine. |
| 4. ____ Air Dome | (D) Re-circulates and removes wash and rinse water. |
| 5. ____ Washing Machine Motor | (E) Directs fresh water into the tub. |
| 6. ____ Agitate Solenoid | (F) Actuates the water level switch by sensing amount of water in tub. |
| 7. ____ Timer Motor | (G) Activates mixing valve when water level is changed. |
| 8. ____ Cam Bar | (H) Engages transmission to cause machine to spin or agitate. |
| 9. ____ Water Pump | (I) An electrical switch that converts electrical energy into mechanical energy into agitate position. |
| 10. ____ Spin Solenoid | (J) An electrical switch that converts electrical energy into mechanical energy and moves the cam bar to spin position. |

Job Sheet MA-10a

Go to your instructor and he will give you a box of tagged assorted parts. Look at the tag number and record it on this sheet. Write down the name of the part and tell what it does in the space provided. Try to identify what make machine the part came from (Kenmore, G.E., Maytag, etc.).

| Tag No. | Name of Part | Function | Make of Machine |
|---|---|---|---|
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Go to your instructor and have him assign you a washer to disassemble using previous information and this check sheet:

1. Tear down the washer.
2. Identify and label the parts as you remove them.
3. Have your instructor check your work.
4. Reassemble the machine.
5. Have your instructor check your work.

If you have problems ask your instructor.

Instructions for disassembly of a Kenmore washer:

Check mark each step as you proceed:

1. Disconnect the machine from the electrical and water supply.
2. Turn the timer knob counter clockwise and remove.
3. Remove the indicator dial.
4. Remove the console front.
5. Disconnect the wiring harness plug.
6. Remove the air hose from the water level control.
7. Remove the knobs from the water level control and the temperature control.
8. Remove the screws holding the switches and timer to the front.
9. Open the lid grasp the front and pull up and forward.
10. Remove the green grounding wires.
11. Pull the harness plug down through the top.
12. Lift the top off of the hinge pieces.
13. Remove the ½" nut holding the damper pad and frame in place.
14. Remove the clips holding the tub ring down.
15. Remove the hose connecting siphon gap to the mixing valve.
16. Remove the tub ring and gasket.
17. Remove the agitator cap and agitator.
18. Remove the drive collar and tub nut and lift out the tub.
19. Remove the drive block.
20. Remove the mixing valve.
21. Lay a pad on the floor and lay the washer cabinet on its front.
22. Remove the back panel.
23. Remove the wires from the motor and magnet control.
24. Remove the self cleaning filter (if there is one).
25. Remove the hoses from the pump.
26. Remove the two ½" bolts from the pump.
27. Remove the bolts from the braces.
28. Remove the three bolts from the gear case that holds it to the base plate.
29. Remove the springs and retaining clip that holds down the clutch yoke.
30. Remove the 9/16" nuts that hold the motor bracket to the base plate.
31. Remove the gear case then the spin tube.
32. Check with the instructor.

Reassembly

Reassembly is basically a reversal of the tear down procedure. Start at step 31 and work backwards. Take special care in locating correct wires and hoses. Cross your disassembly check mark as you proceed. (✓). When finished contact your instructor.

**MAJOR BLOCK** Major Appliances **NAME** _____

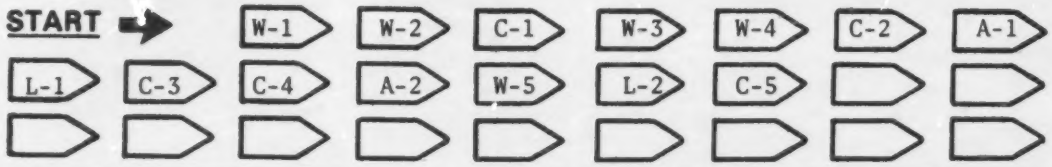
**TASK** Troubleshooting Washing Machine

**UNIT** Electrical Systems Operation and Troubleshooting **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-11

**OBJECTIVE(S)**

Identify the components and troubleshoot washing machine electrical system.




**WRITTEN ASSIGNMENT(S)**

| | |
|---|---|
| W-1 | Information Sheet MA-11a |
| W-2 | Assignment Sheet MA-11a |
| W-3 | Information Sheet MA-11b |
| W-4 | Assignment Sheet MA-11b |
| W-5 | Information Sheet MA-11c |
| W-6 | |
| W-7 | |

**AUDIOVISUAL(S)**

| | |
|---|---|
| A-1 | Slide Set MA-11a |
| A-2 | Slide Set MA-11b |
| A-3 | |
| A-4 | |
| A-5 | |
| A-6 | |
| A-7 | |

**LABORATORY ASSIGNMENT(S)**

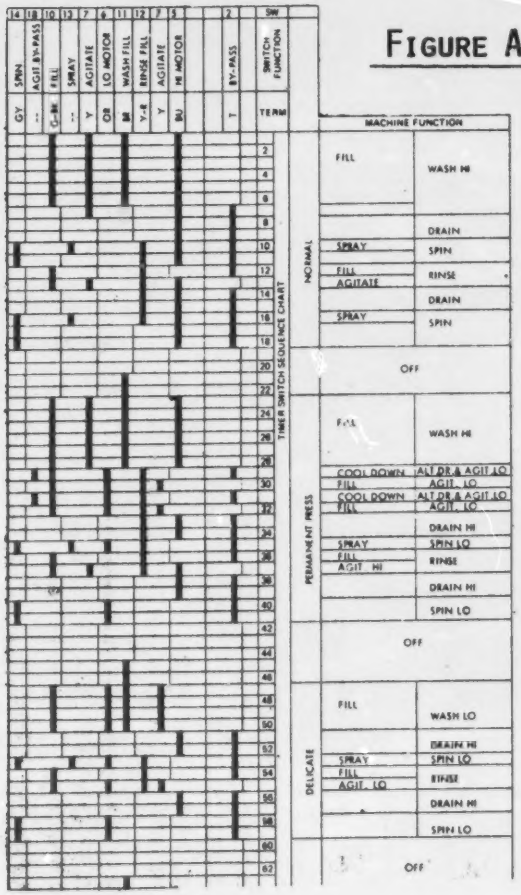
| | |
|---|---|
| L-1 | Job Sheet MA-11a |
| L-2 | Job SHeet MA-11b |
| L-3 | |
| L-4 | |
| L-5 | |
| L-6 | |
| L-7 | |
| L-8 | |
| L-9 | |

**CHECKPOINT(S)**

| | |
|---|---|
| C-1 | Instructor Check |
| C-2 | Instructor Check |
| C-3 | Instructor Check |
| C-4 | Instructor Check |
| C-5 | Instructor Check |
| C-6 | |
| C-7 | |
| C-8 | |
| C-9 | |

In the appliance servicing business a document known as an "esterline chart" has great importance to the appliance service technician. It explains the washing machine functions which are operating at each step of the cycle (see Figure A). Across the top of the chart is a row of numbers, these numbers refer to the switches in the machine and are indicated by the numbers on the diagram. Below these numbers are letters which identify the switches by color code on the timer.

## FIGURE A



In the appliance servicing business a document known as an "esterline chart" has great importance to the appliance service technician. It explains the washing machine functions which are operating at each step of the cycle (see figure A). Across the top of the chart is a row of numbers, these numbers refer to the switches in the machine and are indicated by the numbers on the diagram. Below these numbers are letters which identify the switches by color code on the timer.

The actual function of the switches can be determined by using the numbers and letters on the chart. The numbers down the right side of the chart indicate the timer steps. The machine functions are on the far right. The heavy black lines which are vertical in the chart show that the switches are closed. For example, notice switch number 7 which controls the agitate solenoid. Locate the number at the top and follow the column down the chart. By doing this the reader can determine that the switch is closed for steps 1-7, 22-28, 30, 32-36, 40-44 and 53-68. If the machine will not agitate at the proper time in the cycle, set the timer dial to the agitate cycle. At this time, by checking the circuit with an ohmmeter or a voltmeter, it can be determined if the problem is in the timer or another component of the circuit. To identify a problem in one of the timer steps, such as a buzzing sound (which often indicates a solenoid problem) in timer step number 6, locate the timer step where the problem occurs then follow across in a straight line (see figure B). It can be seen that the switches closed at this step are the SIS by-pass, master switch, bleach, Hi motor, agitate, hot and cold valves. The only one that would start and stop is the switch that controls the bleach dispenser. By checking the bleach dispenser it would most likely be found that the bleach dispenser, is the problem.

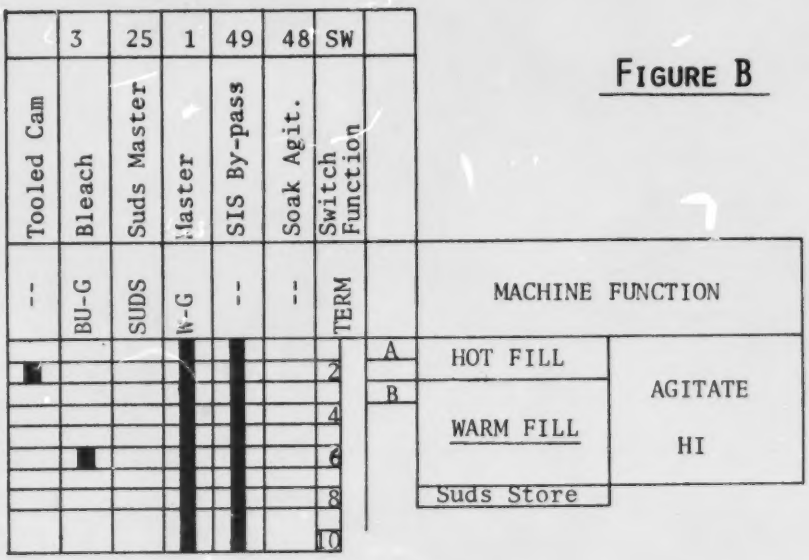



FIGURE B

The function of the machine is as follows. (1) When the machine is turned on to timer step number one and the knob is pushed "ON", switches 49, 1, 5, 7, and 11 are closed to complete the path shown by the short arrows in Figure C. This path is for the fill circuit which involves the hot valve only. (2) When the machine reaches the desired water level, the water level switch moves to the position shown by the dotted lines from P to the full marking. (3) Then the circuit follows the path of the long arrows starting at the water level switch. This circuit is for the wash cycle with high speed agitation. As can be seen by the diagram, there are two circuits closed, one is for the high speed motor and the other for the agitate solenoid circuit. (4) As the machine progresses to timer step number six, switch number two closes (enclosed in circle). This switch is used to by-pass the water level control when the timer advances to the next timer step which is the drain portion of the cycle. (5) When the machine reaches this step, switch number seven opens and cuts off the agitate solenoid. The pump is activated by a cam bar which is operated by the agitate solenoid. At the same time, switch number 11 opens keeping the machine from filling when the water level switch resets. (6) The drain is for one timer step before switch number 14 closes and the machine starts to spin. (7) The spin solenoid circuit is shown by the thick arrows in Figure B which starts at the water level control. During the first part of the spin, timer switch number 13 alternately opens and closes spraying water into the spinning clothes to rinse them. This switch is indicated by a square. (8) At the end of timer step (number nine) timer switches five and 14 open and switches 11 and 17 close to provide warm water for the rinse. This circuit is the same except for warm water for the rinse. (9) The cold water is energized at timer switch 11 (dotted arrows). (10) After the spin ends, the cycle starts back as it was at the beginning of the cycle.

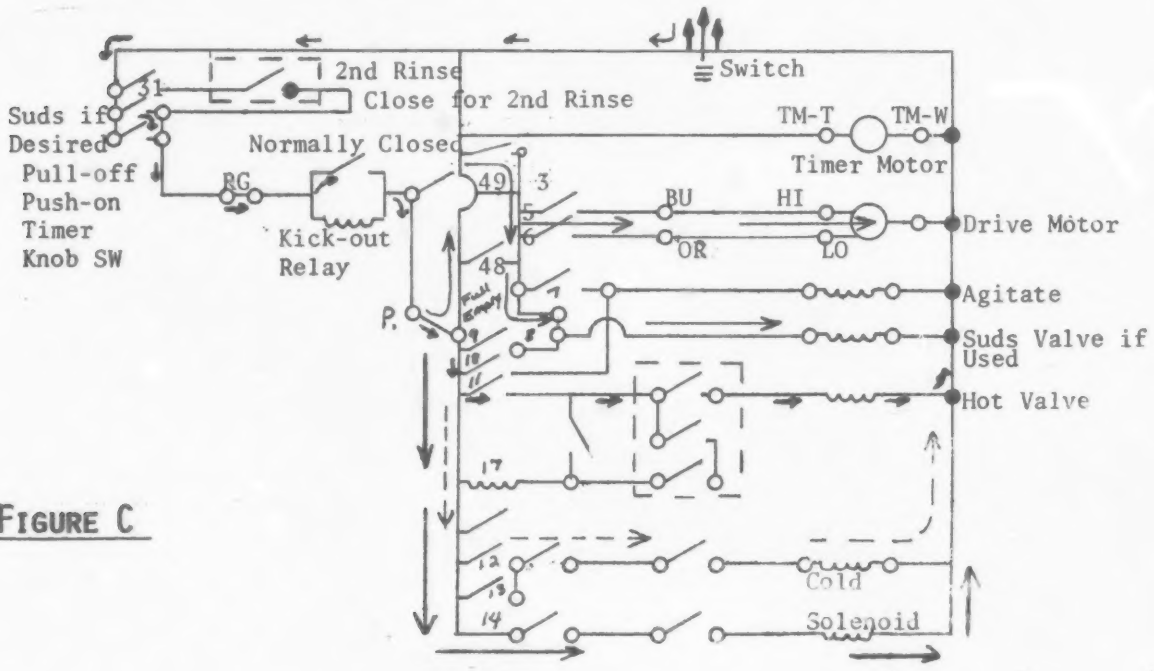



FIGURE C

Assignment Sheet MA-11a

Use the esterline chart and the schematic in Information Sheet MA-11a to identify the following machine cycles and timer function steps:

1. What timer steps are functional when switch number 13 is closed?

   A. _____ C. _____

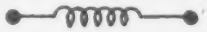
   B. _____ D. _____

2. At which timer step does the first agitate cycle end?

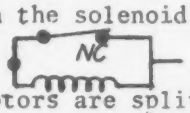
3. What does switch number six control?

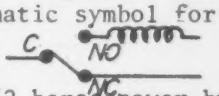
4. What number is used to identify the master switch?

5. What switch number is used to identify the spray rinse?

All solenoids used on automatic washing machines work the same regardless of their physical appearance. The solenoid is a device, that when energized, will create a magnetic field and cause some component control to open or close. Solenoids are used for mixing valves, knock out switches, relays, dispensers and braking and shifting devices. The schematic symbol for a solenoid is 

Water level switches (controls) are simply switchs operated by the movement of a diaphragm which in turn controlled by water pressure or air. On modern washers, the diaphragm controlling force is usually air pressure caused by water forcing air up a small tube. Most of the controls are adjustable by increasing or decreasing spring pressure on the diaphragm so that it takes more or less pressure to activate the switch. The schematic diagram for the water level control is


The "kickout" or "off balance" switch is nothing more than a switch operated by a solenoid. When the mechanism becomes off balanced the tub or base plate moves off center, when this occurs the base plate strikes a lever attached to the solenoid. This can be accomplished by having the switch in parallel or in series with the solenoid coil. The schematic symbol for this is either 

or 


Most washer motors are split phase 1/3 or 1/2 horse power but some motors are capacitor-start induction-run. Some of the motors are two or three speed and some are reversible. The reversing is accomplished by the timer. Most motors incorporate a centrifugal switch for the purpose of disengaging the start winding. General Electric washers use a current type starting relay for this purpose.

The timer used on automatic washers is nothing more than several switches generated by a motor driven cam. The timer motor is a synchronous type motor that has a speed reduction gearcase attached to it. The motor drives an escapement that causes the cam to move a few degrees of rotation at a time instead of a continuous movement. The movement of the cam a few degrees at a time insures a snap action of the contacts. A timer consists of (1) motor, (2) escapement, (3) multiple circuit cam switches. Figure D is the escapement. Figure E is the cam switches and Figure F is the timer motor. The timer controls the length and functions of the washer by opening and closing the electrical circuits of the washer.

FIGURE D

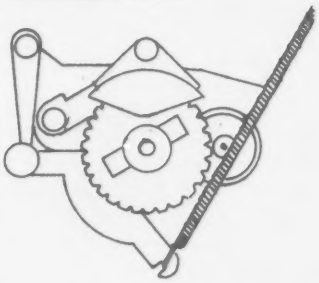


FIGURE E

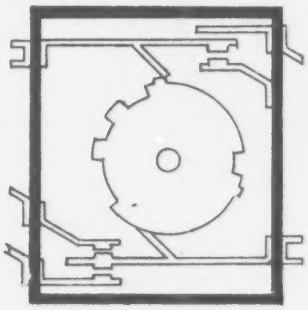
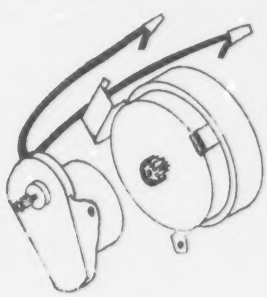


FIGURE F



1. What is the purpose of an escapement in a timer?

2. What are the three parts of a timer?

   1. _____

   2. _____

   3. _____

3. What two forces can be used to operate a water level control?

   1. _____

   2. _____

4. What is the principle of operation of a solenoid?

5. What are the two types of motors used on washing machines?

   1. _____

   2. _____

In troubleshooting the electrical system of a washing machine, always check the voltage source first. The problem may be in the distribution box or in wires leading from there to the washing machine. This can be done with a voltage tester. If the correct voltage is leading to the washing machine outlet the trouble must be in the electrical system of the washer. In the washer as with most appliances there are several circuits. The first step is to determine which of the circuits can be at fault. So remember to isolate each circuit to determine the exact location of the problem. The electrical problem can usually be identified as specific types. For example: (1) they will not operate, (2) they won't fill (hot, cold, or warm), (3) they won't agitate, (4) they won't spin, (5) the timer will not advance, (6) the water will not cut off, (7) the machine runs briefly and cuts off, (8) the dispensers won't work.

When the washer will not operate, first check the power coming to the machine. If there is no power, check the circuit protector in the distribution panel. If there is power, the problem is apparently in the machine.

If the power source is O.K., the next thing to check would be the washer's master switch and the push-pull timer switches. Attach one meter lead to the black wire coming from the power cord and the other to the RG terminal. If the meter reads 110 volts the problem is between the meter leads, which could be one or both of these switches. If no voltage shows the problem is somewhere else. Using the meter check with one lead to "RG" and the other to "p" on the water level control. If voltage is evident the problem is in the water level control. If the problem is not identified at this point it may show up in several other components. Check form "y" on the water level control to "Bk" on the timer. If voltage is evident the problem is certainly the timer.

If the machine will not fill or only hot or cold water will come into the machine, check the valve coil. It probably is not functioning and a voltage reading should not be evident. If voltage does appear it is the coil at fault and may need to be replaced. If the coil is functioning properly check the water temperature switch. Check the diagram to determine the coil circuits which should be checked. If source voltage is found on any of the checkpoints the temperature switch will be the problem. If the coil circuits check out okay, check voltage on the timer from "P" to "BR" or from "P" to "G-Bk" or from "P" to "Y-K". If source voltage is evident on any switch that should be closed the switch will be bad and replacement will be necessary. This is the last check to be performed when the machine will not fill. If the electrical problem is not found, the student should double check his or her work by repeating the steps.

Sometimes the washing machine will not agitate. First check the voltage across the agitate solenoid. If source voltage is found in the magnetic control the problem has been identified. Replacement will probably be necessary. If voltage is not evident in the magnetic control, check across timer contacts "Y" to "T" or the water level control "T" to "V". Source voltage across either contact would indicate a bad switch.

If the machine will not spin, check for voltage at the spin solenoids. If the machine timer is set at the spin cycle, voltage should be read at the solenoid. If voltage is reaching the solenoid then replacement may be necessary.

The lid switch is designed to shut down the machine when the lid is opened. If the switch is not functioning properly it may keep the spin cycle from operating

The next problem is that "the timer will not advance". First check to see if the motor is turning. Check the voltage at the motor. Check the gears and escapement for possible faults (broken gears or stripped gears). If the water will not cut off, first check by unplugging the machine to make sure the problem is electrical. If the problem is electrical, check the voltage across the water level control "V" to "P". If no voltage is present this means the contacts are not opening, so replace the water level control. If the machine runs briefly and cuts off, check the voltage at the motor. If less than 99 volts are read with the motor running, check the timer contacts. Check timer contacts P to BU for high and P to OR for low; if more than zero volts are read, replace the timer.

Another fault is that the motor is trying to run at both high and low speeds at the same time. If this is the case, check for power across white and orange and white and blue. If power is found in both places, unplug the machine and remove the orange wire from the motor, insulate it, and operate the machine. Check the motor again to determine if it is operating correctly. Check the wiring harness for shorts. Next, check the timer terminals "TW-W" to "OR" and "TM-W" to "BU"; if power is discovered across both sets of contacts, replace the timer.

A final problem which may remain is the dispensers do not work. To diagnose this problem, first check the voltage at the dispenser solenoid. Then, check the appropriate timer contacts T to O-BK to determine if fabric conditioner dispenser is operational. V to P-BK will determine if detergent is being dispensed. Check T to BU-G to detemine if the bleach is being dispensed correctly.

Remember that safety is always important. When possible use insulated alligator clips on terminals. Always keep yourself and your work area dry and use safety glasses.

The instructor will assign a washing machine on which all components of the electrical system should be removed and replaced.

1. Remove all the electrical components.
2. Label the parts.
3. Ask the instructor to examine the labeled parts.
4. Replace the electrical parts.
5. Return the washing machine to its assigned location.
6. Clean up your work area.

Job Sheet MA-11b

The instructor will assign a machine or machines to perform the steps of troubleshooting and repairing.

1. Using a voltmeter find the electrical problems in the machine.

2. Report your findings to the instructor then make repairs according to the instructions given at this checkpoint.

3. Clean up the work area and return all parts and tools to their proper locations.

**MAJOR BLOCK** Major Appliance **NAME** _____

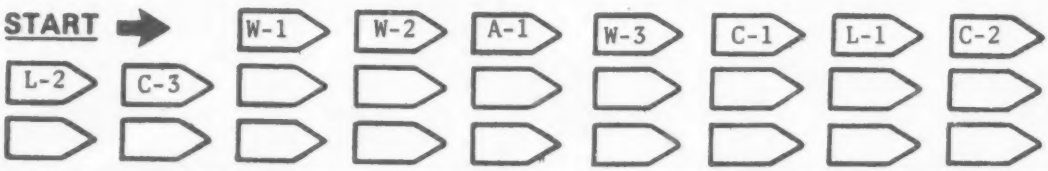
**TASK** Troubleshooting Washing Machines

**UNIT** Testing and Installing Capacitors **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-12

**OBJECTIVE(S)**

Check and install capacitors on automatic washing machines.




**WRITTEN ASSIGNMENT(S)**

W-1 Information Sheet MA-12a
W-2 Information Sheet MA-12b
W-3 Assignment Sheet MA-12a
W-4
W-5
W-6
W-7

**AUDIOVISUAL(S)**

A-1 Slide Set MA-12a
A-2
A-3
A-4
A-5
A-6
A-7

**LABORATORY ASSIGNMENT(S)**

L-1 Job Sheet MA-12a
L-2 Job Sheet MA-12b
L-3
L-4
L-5
L-6
L-7
L-8
L-9

**CHECKPOINT(S)**

C-1 Instructor Check
C-2 Instructor Check
C-3 Instructor Check
C-4
C-5
C-6
C-7
C-8
C-9

Generally washing machines use a capacitor-start motor. This is because additional amperage is needed to start the motor. As a result, this means that two coils are utilized to start the motor. As the motor approaches 80% of its potential speed (nearly full speed), the START coil of the motor is disengaged and the top speed of the motor is maintained by the RUN coil, (see figure A). Most washing machine capacitor-start motors are of three types: (1) single-speed nonreversible, (2) single-speed reversible, and (3) two-speed nonreversible.

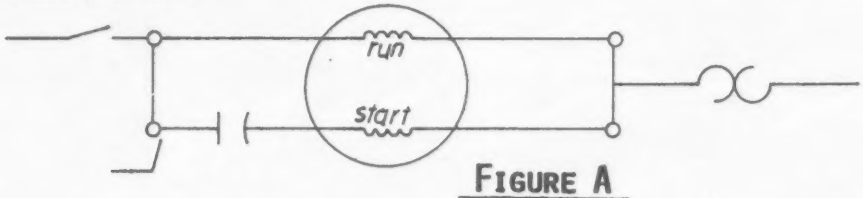



FIGURE A

Defective capacitors are the major causes for problems in motors of this type. Problems which may arise with the capacitor-start motor are: (1) motor hums but will not start, (2) motor starts but will not reach top speed. If either of these problems occur it could be due to the common wiring leading to the windings, shortage in one or both of the run and start windings, an open overload relay, or an open timer switch. The best way to determine whether a capacitor is faulty is to replace it with a new one though a specific procedure for checking them is also available. This procedure will be covered in latter activities of this unit.

Procedure for Testing a Washing Machine Motor Start Capacitor

1. Remove all external wiring from the capacitor.
2. Using a V.O.M. set the range switch to RX100.
3. Set the function to "plus" DC.
4. Attach the meter leads to the capacitor terminals.
5. If the meter pointer deflects up the scale and returns to infinity, the capacitor is good.
6. If the meter pointer deflects up the scale and stays, the capacitor is shorted.
7. If the meter pointer deflects up scale and returns part of the way, the capacitor is leaky.

Finding the Capacitor on Automatic Washers.

1. Some capacitors are mounted on the side of the motor.

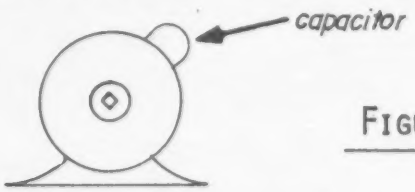



FIGURE B

2. Some, like Westinghouse, are mounted on the inside of the washer cabinet.

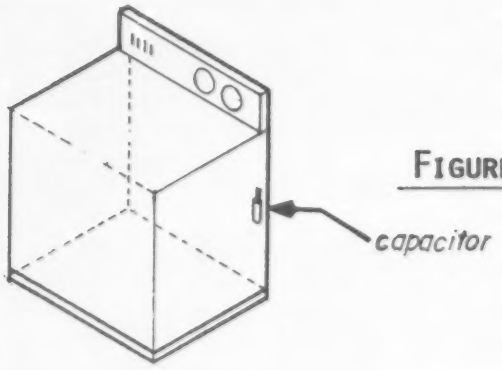



FIGURE C

3. On some Frigidaire machines the capacitor was located in the timer console.

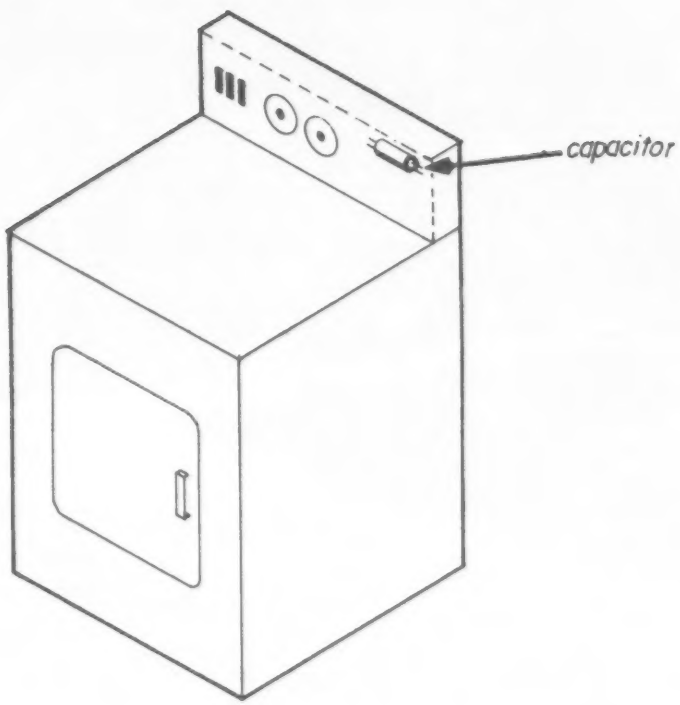



FIGURE D

1. Identify the components of the following schematic:

A. _____ D. _____

B. _____ E. _____

C. _____ F. _____

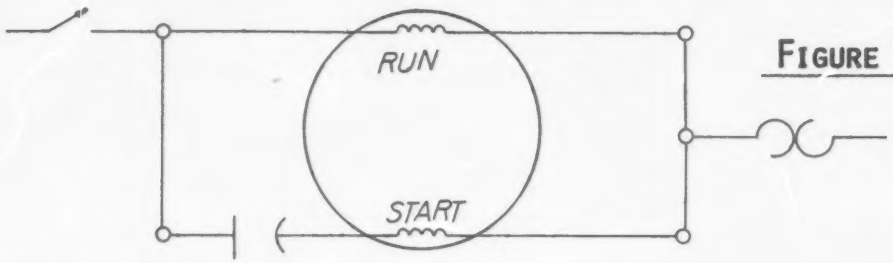



FIGURE E

2. List two characteristics of a motor with a bad capacitor:

A. _____

B. _____

3. List three additional problems which may occur as a result of the preceding schematic of capacitor-start electric motor.

A. _____

B. _____

C. _____

The instructor will assign several capacitors to identify the ratings. Label each of the capacitors with a number and record its appropriate ratings.

| Capacitor | Rating |
|---|---|
| #1 | _____ |
| #2 | _____ |
| #3 | _____ |
| #4 | _____ |
| #5 | _____ |

The instructor will assign several appliances on which the capacitor should be checked and diagnosed. Record the results here:

| | | Capacitor Rating | Capacitor Malfunction | Corrective Procedure | Capacitor is Functional |
|---|---|---|---|---|---|
| A. | Appliance #1 | _____ | _____ | _____ | _____ |
| | Appliance #2 | _____ | _____ | _____ | _____ |
| | Appliance #3 | _____ | _____ | _____ | _____ |
| | Appliance #4 | _____ | _____ | _____ | _____ |
| | Appliance #5 | _____ | _____ | _____ | _____ |

B. Diagnose at least one malfunctioning capacitor and replace it with a functioning capacitor of the appropriate rating.

The instructor will assign several capacitors to identify the ratings on. Label each of the capacitors with a number and record its appropriate rating.

| | Rating |
|---|---|
| 1. Capacitor #1 | _____ |
| 2. Capacitor #2 | _____ |
| 3. Capacitor #3 | _____ |
| 4. Capacitor #4 | _____ |
| 5. Capacitor #5 | _____ |

The instructor will assign several appliances on which the capacitor should be checked and diagnosed. Record the results here:

| | | Capacitor Rating | Capacitor Malfunction | Corrective Procedure | Capacitor is Functional |
|---|---|---|---|---|---|
| A. | Appliance #1 | _____ | _____ | _____ | _____ |
| | Appliance #2 | _____ | _____ | _____ | _____ |
| | Appliance #3 | _____ | _____ | _____ | _____ |
| | Appliance #4 | _____ | _____ | _____ | _____ |
| | Appliance #5 | _____ | _____ | _____ | _____ |

B. Diagnose at least one malfunctioning capacitor and replace it with a functioning capacitor of the appropriate rating.

**MAJOR BLOCK** Servicing Major Appliances **NAME** _____

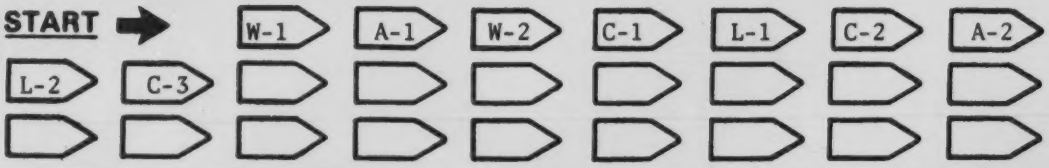
**TASK** Troubleshooting Washing Machines

**UNIT** Mechanical Systems Operation and Troubleshooting **TIME (est.)** _____ **(act.)** _____

**UNIT NO.** MA-13

**OBJECTIVE(S)**

Identify and install the components of the mechanical system of an automatic washing machine.




**WRITTEN ASSIGNMENT(S)**

**W-1** Text Assignment MA-13a
**W-2** Assignment Sheet MA-13a
**W-3** _____
**W-4** _____
**W-5** _____
**W-6** _____
**W-7** _____

**AUDIOVISUAL(S)**

**A-1** Slide Set MA-13a
**A-2** Slide Set MA-13b
**A-3** _____
**A-4** _____
**A-5** _____
**A-6** _____
**A-7** _____

**LABORATORY ASSIGNMENT(S)**

**L-1** Job Sheet MA-13a
**L-2** Job Sheet MA-13b
**L-3** _____
**L-4** _____
**L-5** _____
**L-6** _____
**L-7** _____
**L-8** _____
**L-9** _____

**CHECKPOINT(S)**

**C-1** Instructor Check
**C-2** Instructor Check
**C-3** Instructor Check
**C-4** _____
**C-5** _____
**C-6** _____
**C-7** _____
**C-8** _____
**C-9** _____

1. List the three mechanical systems in a washer.

2. What part connects the main drive gear to the sector gear?

3. Does the water level have anything to do with the spin cycle?

4. Explain what happens when the spin cam bar is moved forward.

1. See the instructor for assignment to a washer to work on.

2. Remove the mechanical systems from the machine.

3. Label the parts of the mechanical systems.

4. Get the instructor to check your work.

5. Reassemble the machine.

6. Again have the instructor check your work.

7. Clean up the work area and return tools to their proper location.

The instructor will provide a machine on which servicing of the mechanical system is needed. Follow the appropriate servicing procedures and correct the problem. Use the following check list as a guide for locating such a problem.

**MAJOR BLOCK** Major Appliance **NAME** _____

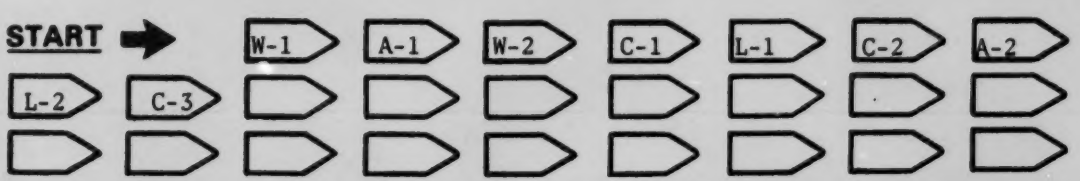
**TASK** Troubleshooting Washing Machines

**UNIT** Checking and Replacing Belts **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-14

**OBJECTIVE(S)**

Check, identify belt types, and adjust tension on belts.




**WRITTEN ASSIGNMENT(S)**

| | |
|---|---|
| W-1 | Information Sheet MA-14a |
| W-2 | Assignment Sheet MA-14a |
| W-3 | |
| W-4 | |
| W-5 | |
| W-6 | |
| W-7 | |

**AUDIOVISUAL(S)**

| | |
|---|---|
| A-1 | Slide/Tape MA-14a |
| A-2 | Slide/Tape MA-14b |
| A-3 | |
| A-4 | |
| A-5 | |
| A-6 | |
| A-7 | |

**LABORATORY ASSIGNMENT(S)**

| | |
|---|---|
| L-1 | Job Sheet MA-14a |
| L-2 | Job Sheet MA-14b |
| L-3 | |
| L-4 | |
| L-5 | |
| L-6 | |
| L-7 | |
| L-8 | |
| L-9 | |

**CHECKPOINT(S)**

| | |
|---|---|
| C-1 | Instructor Check |
| C-2 | Instructor Check |
| C-3 | Instructor Check |
| C-4 | |
| C-5 | |
| C-6 | |
| C-7 | |
| C-8 | |
| C-9 | |

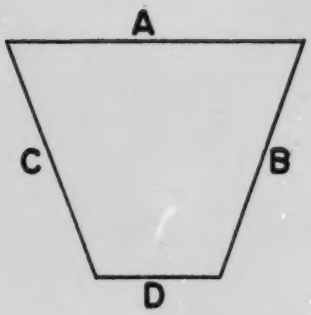
## Identifying Belts and Belt Problems

On most washers the main power transmission source is a "V" type belt. The work surface is on the sides of the belts and if any sign of wear exists, the belt should be replaced. The most common problem is due to stretching, however, the belt can be retightened if no wear is apparent on the sides. Whenever it is necessary to replace a belt, always use the exact replacement belt.

When adjusting the belt tension, don't over tighten the belt. This can cause problems with the motor bushings, pump bushings and can also cause the motor to overheat and burn out.

The following belt problems are those that require belt changing:

1. Wear on the sides (indicated by a slick appearance)
2. Burning (indicated by a chared look and will be brittle)
3. Separated layers
4. Broken

1. 


Indicate by letter or letters the work surface of a "V" Belt.

2. List the problems that would warrant the replacement of a belt.

3. Should a notched "V" Belt be replaced by a regular "V" Belt?

4. What usually causes a belt to burn?

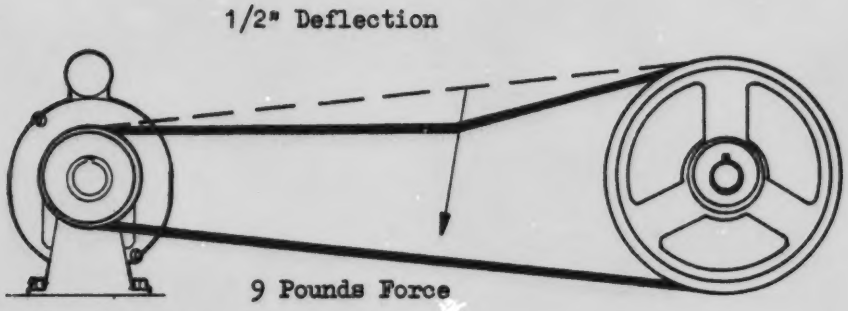
5. What can be done to correct a stretched belt?

Ask the instructor to assign a washing machine on which the belt tension can be adjusted. In order to adjust the tension on the belt, the following steps should be followed:

1. Move the washing machine away from the wall and unplug it.
2. Remove the screws holding the back on.
3. Loosen the nut on the top of the base plate.
4. Use a ball peen hammer to knock the motor bracket to the left which will loosen the tension on the belt.
5. Using a lever, adjust the tension.

   | Using nine pounds of force for new belts and seven pounds of force for old belts, the belt should move inward one/half inch. |
   |---|

6. Retighten the nut on the top of the base plate.
7. Replace the back.



Changing Belts

Ask the instructor for a belt and a machine for changing the drive belt. When a machine has been assigned, check to see what tools will be needed and proceed. (The following procedures will vary according to manufacturer).

1. Lay machine on front side.
2. Remove back panel.
3. Remove old belt.
4. Loosen motor and motor bracket.
5. Remove the brace at the rear of the gearcase.
6. Remove front braces.
7. Remove spacer between the gearcase and the brace.
8. Remove the spring which holds the clutch yoke down on the adjustment pin. It is located at the front side of the gearcase.
9. Push up on the plunger of the spin solenoid and turn the gearcase pulley until the cam bar is all the way back. Push up on clutch pin and pull back on cam bar until it is pulled all the way out of the clutch pin.
10. Loosen the pump from the gearcase.
11. Maneuver the belt onto the clutch and motor pulley.
12. Reassemble the parts of the gearcase, pump and braces.
13. Adjust tension of belt.
14. Replace the back panel and test the machine.

**MAJOR BLOCK** Major Appliance **NAME** _____

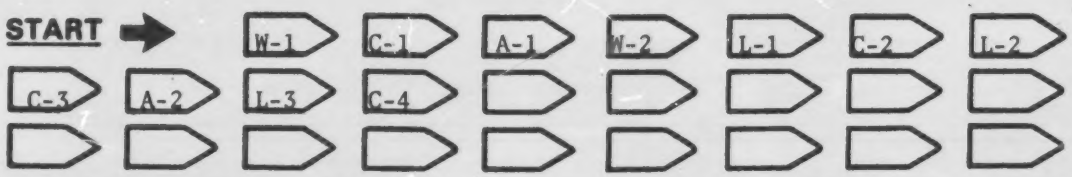
**TASK** Troubleshooting Washing Machines

**UNIT** Water Systems Operation and Trouble-shooting **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-15

**OBJECTIVE(S)**

Diagnose and service/repair washing machine water system.




**WRITTEN ASSIGNMENT(S)**

**W-1** Information Sheet MA-15a
**W-2** Information Sheet MA-15b
**W-3** _____
**W-4** _____
**W-5** _____
**W-6** _____
**W-7** _____

**AUDIOVISUAL(S)**

**A-1** Slide Set MA-15a
**A-2** Slide Set MA-15b
**A-3** _____
**A-4** _____
**A-5** _____
**A-6** _____
**A-7** _____

**LABORATORY ASSIGNMENT(S)**

**L-1** Job Sheet MA-15a
**L-2** Job Sheet MA-15b
**L-3** Job Sheet MA-15c
**L-4** _____
**L-5** _____
**L-6** _____
**L-7** _____
**L-8** _____
**L-9** _____

**CHECKPOINT(S)**

**C-1** Instructor Check
**C-2** Instructor Check
**C-3** Instructor Check
**C-4** Instructor Check
**C-5** _____
**C-6** _____
**C-7** _____
**C-8** _____
**C-9** _____

On washers (See Figure A) there are generally eight components in the water system. They are:

1. mixing valves
2. drain pumps
3. filters
4. dispensers
5. siphon gaps
6. check valves
7. air dome
8. traps

The Kenmore and Whirlpool machines have all the above mentioned devices, and will be discussed in as far as the complete water system is concerned.

As the machine is turned on water circulates through the mixing valve and enters the tub through the siphon gap. As the water level rises it traps air in the air dome and compresses it through a small diameter hose causing the water level switch to activate the motor circuit. This happens once the correct water level has been reached (See Figure B). When the motor starts, the pump lever is in such a position that the water flows out of the side of the tub through the check valve, filter, pump and pin trap into the bottom of the tub. This path causes any lint in the water to become trapped in the self cleaning filter and held there during the wash cycle.

When the wash cycle has completed, a cam bar, controlled by the agitate solenoid, is pushed toward the front of the machine. (See Figure C). This causes the flapper valve to reverse the direction of water flow. The water now flows from the bottom of the tub through the pin trap, filter, check valve and out the drain. This reverse circulation of water flushes out the filter and drains the machine.

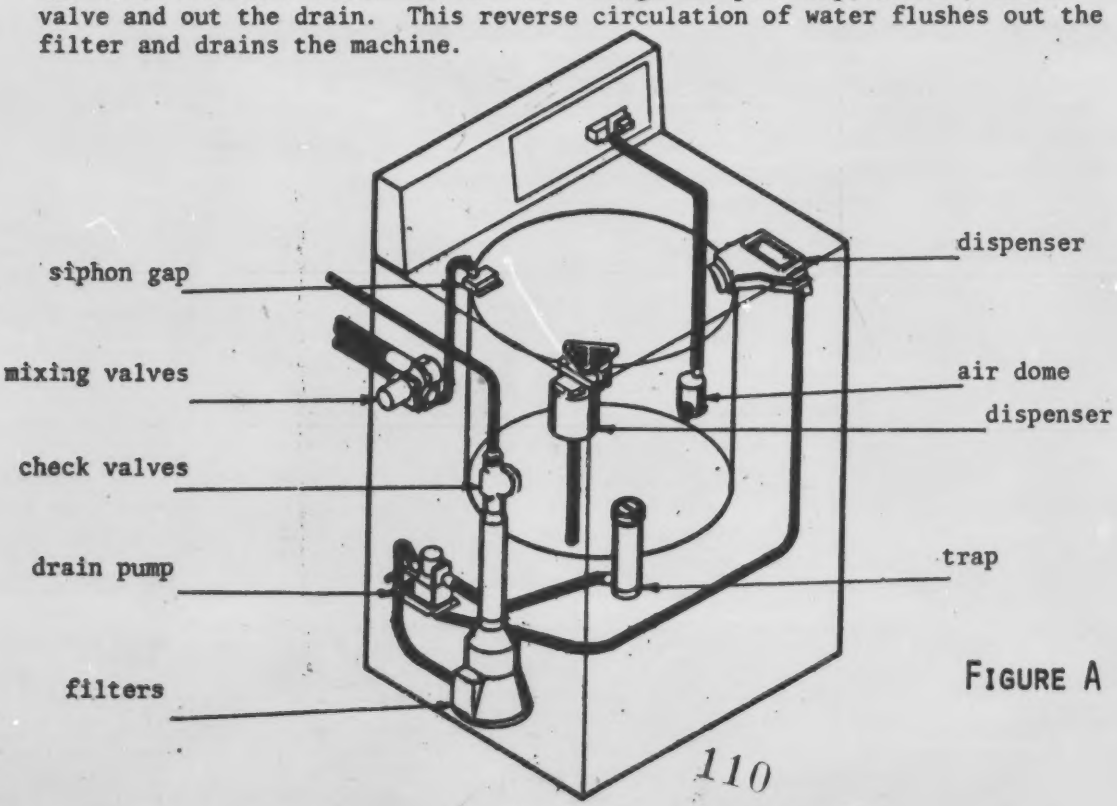



FIGURE A

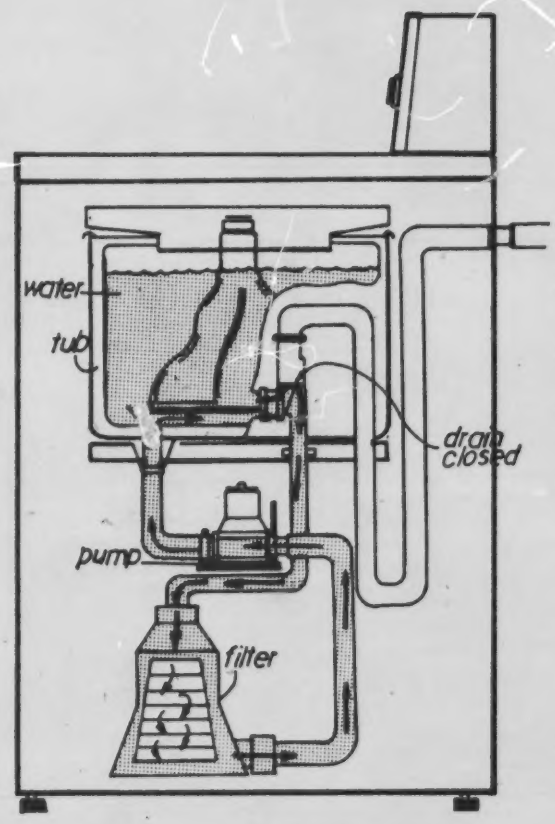



FIGURE B

WATER RECIRCULATING AFTER WASHING MACHINE HAS FILLED AND IN AGITATE CYCLE.

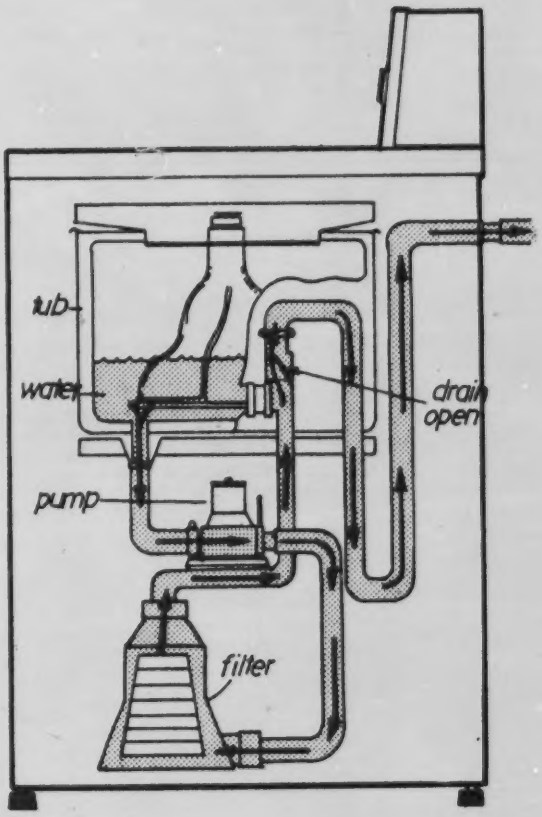



FIGURE C

FILTER BEING CLEANED AS WATER IS BEING DRAINED FROM MACHINE.

## Mixing Valves

The mixing valve (Figure D) is found on every automatic washer made today. The purpose is to control the water flow into the machine and to mix equal amounts of hot and cold water for warm wash. Most machines have a two part valve. One side is for hot water the other for cold.

Water flow through the valve is controlled by a rubber diaphragm.

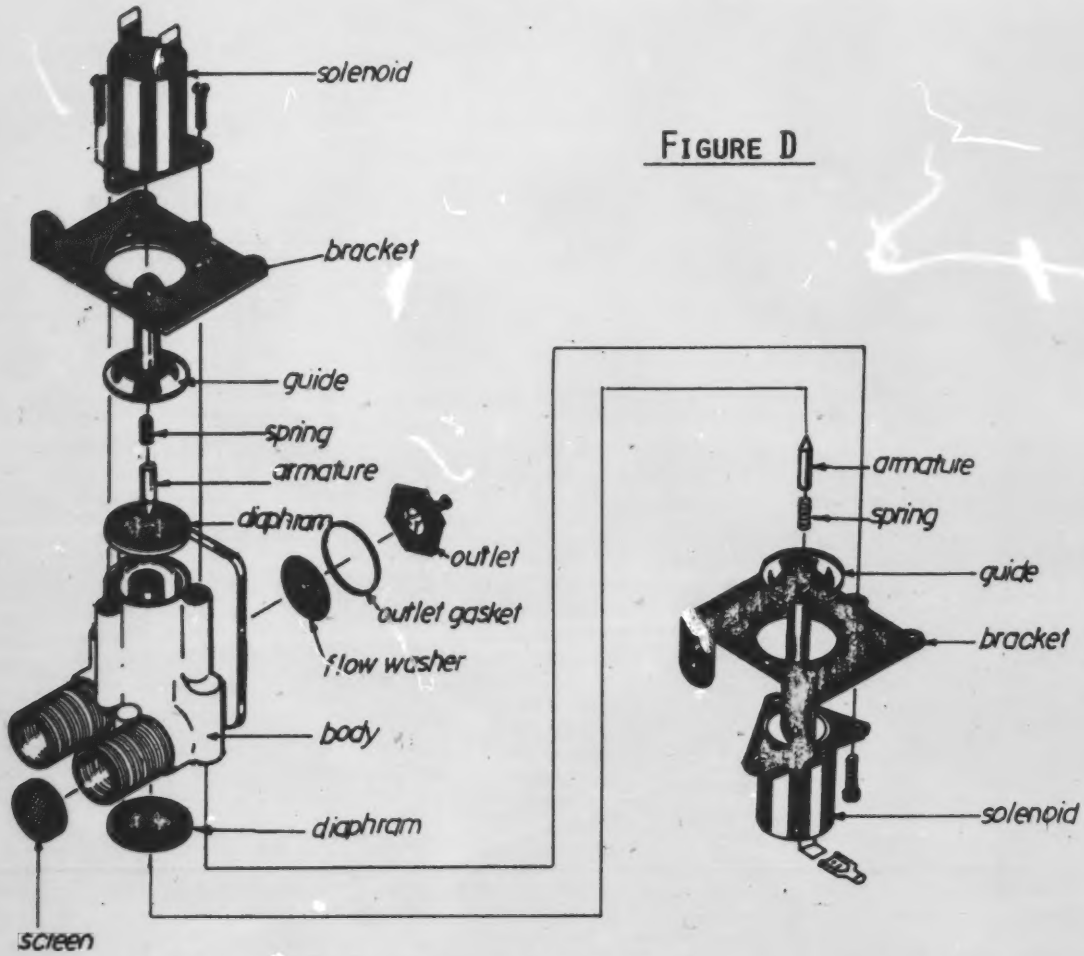
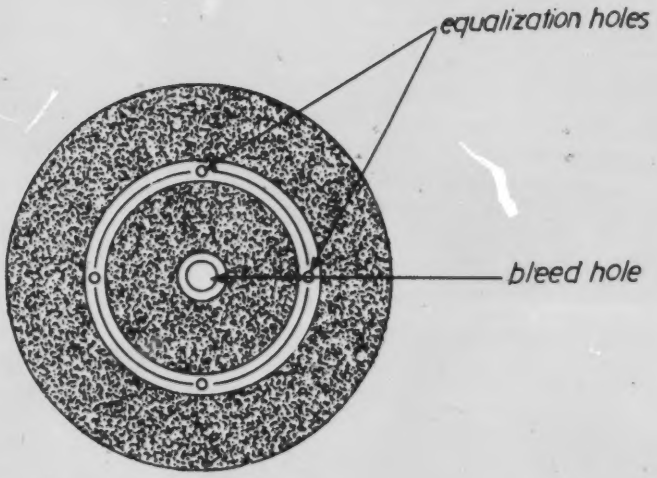



FIGURE D

The valve is put together with the diaphragm on the valve body, the armature in the center, and a spring is on top to be inserted into the guide. This is held in place with a bracket. The solenoid is then placed over the guide.

The operation of the valve is based on "Pascal's Law" which states that a liquid transfers pressures equally in all directions. The water pressure below the diaphragm pushes only on the edges of the diaphragm while the water above acts on the total surface (Figure E). The spring holds the valve closed until the solenoid is energized and pulls the armature out of the bleed hole. Since the equalizing holes are quite small, the pressure is reduced, resulting in raising the diaphragm and allowing the water to flow through the valve.

FIGURE E



## Water Pumps

The other water system parts are not as complicated in operation as the mixing valve, nevertheless their operation is just as important. All automatic washers have pumps. The purpose of the pump is, (1) to drain the machine, (2) to circulate water through a filter. The movement of water is carried out by an impeller which catches the water as it spins and forces the water through the various hoses and other components in the same way that a fan catches and circulates air. The direction of water flow for most pumps depends on motor direction but the Whirlpool pump depends on the action of a valve inside the pump body.

Shown below are illustrations of a Whirlpool pump (Figure F), an older style G.E. filter pump (Figure G), and an exploded view of a Westinghouse pump (Figure H).

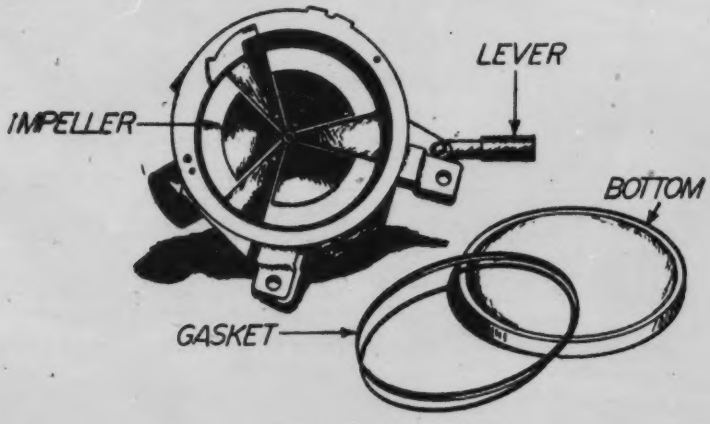



FIGURE F

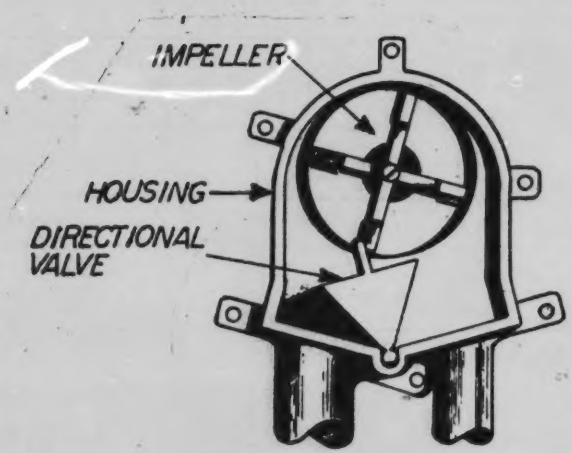



FIGURE G

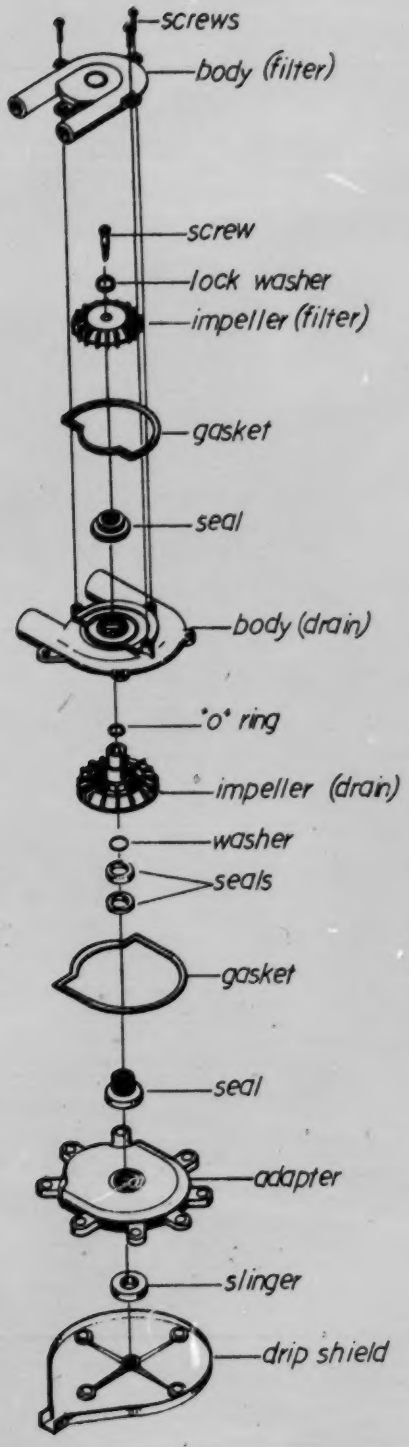

screws
body (filter)
screw
lock washer
impeller (filter)
gasket
seal
body (drain)
"o" ring
impeller (drain)
washer
seals
gasket
seal
adapter
slinger
drip shield

FIGURE H

## Filters

The filters used on most machines are usually a plastic dishshaped device with holes in it to filter out the lint. The Whirlpool machines use several different kinds of filters, some are self-cleaning while others are to be cleaned by the user.

## Dispensers

The various dispensers used on washers usually consist of a storage tank where the outlet is controlled by a solenoid with a float attached to the plunger to prevent over filling. Most detergent dispensers have a holding tank that is linked to the pump to flush out the powdered detergent.

There are a few other components which are found only on Whirlpool/ Kenmore washers. These are check valves and pin traps. The check valve (Figure I) is found on the left side of the tub. The purpose of the valve is to allow the water to flow in different directions for filtering and drain.

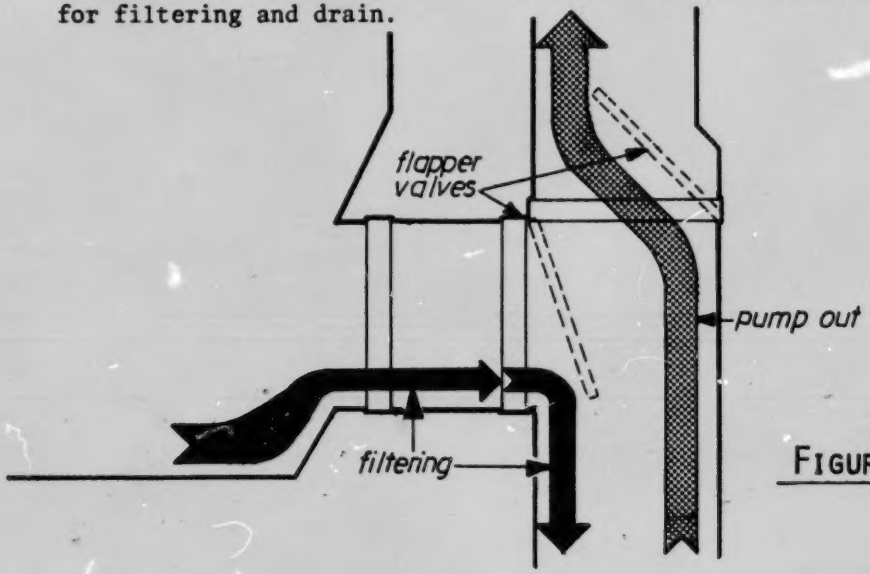



FIGURE I

The pin trap is designed so that objects such as pins, toothpicks, etc., will be trapped to keep them out of the pump.

The instructor will assign a mixing valve on which the following activity can be performed:

1. Disassemble the valve and label the parts. (Figure J)
2. Write a brief description on how the valve operates.
3. Reassemble the valve.

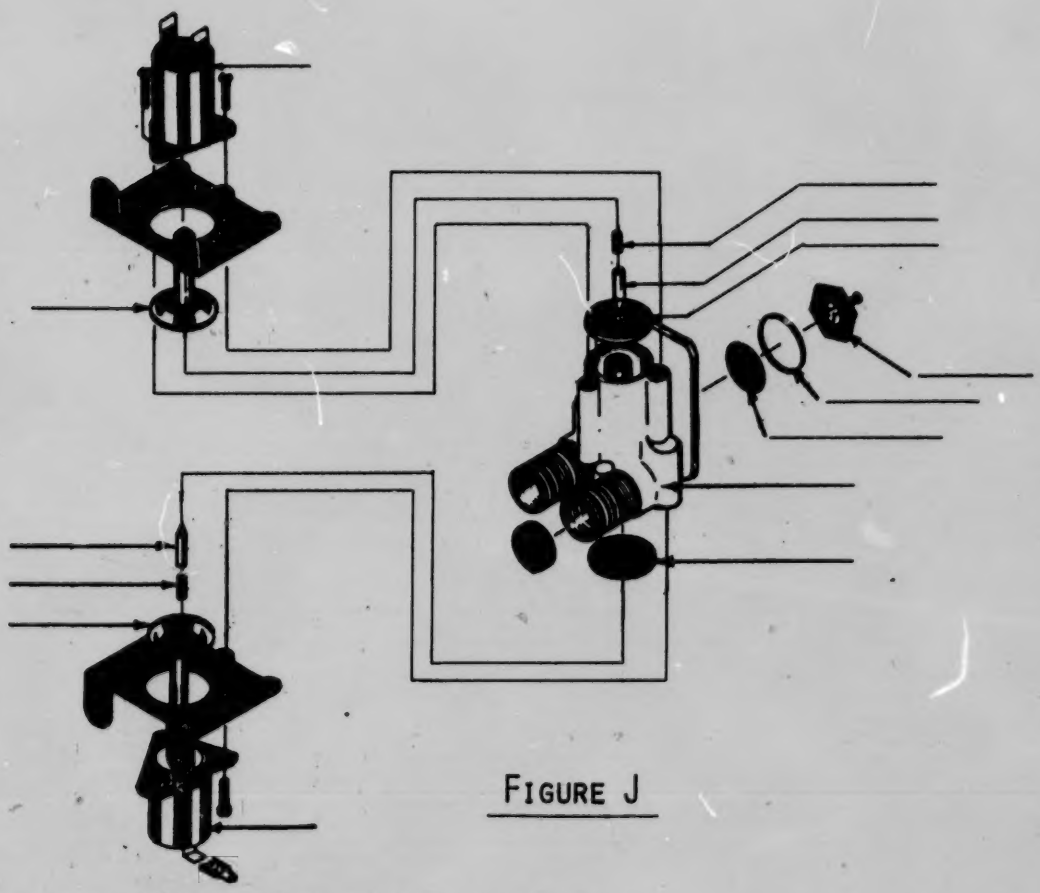


FIGURE J

1. Remove the screw that holds the solenoid in place.
2. Remove the other screws holding the bracket on.
3. Lift the guide, remove the diaphragm.
4. Lift out the armature and spring.

A. Ask the instructor to assign a washer for this activity.

B. Use this check sheet and previous information to dismantle the entire water system and label the different parts.

C. Reassemble the machine and clean up the work area.

1. Disconnect the Kenmore machine from electrical and water supplies.
2. Raise the lid and grasp the inside font of the top opening. Pull it forward and up and lean the top against the wall.
3. Remove the ½" nut holding the damper pad in place. Remove the damper pad.
4. Remove the clips holding the tub ring down and remove the siphon gap from the ring.
5. Remove the agitator cap and the stud below and lift out the agitator.
6. Using a spanner wrench or hammer and punch remove the tub nut (wear safety glasses).
7. Remove the spin basket.
8. Using a face spanner or hammer and punch remove the nut holding the check valve to the left side of the tub (If you use a hammer and punch wear safety glasses).
9. Go to the back of the machine and remove the two 5/16" screws holding the mixing valve in place.
10. Once this is done remove the wires from the solenoids. (The wires will only go back to the solenoid where they were disconnected).
11. Remove the valve. Using hose clamp pliers, remove the hose clamps holding the hoses onto the check valve.
12. Let the top down and lay the washer on the front--remove the back panel and on the right hand side remove the screw holding the filter in place.
13. Remove the top ½" bolts holding the pump to the gear case--use the hose clamp pliers to remove the hoses attached to the pump and filter.
14. Loosen the screw in the clamp holding the manifold to the tub outlet and remove the manifold. This completes the tear down procedure.

15. After tagging parts check with the instructor before proceeding. The reverse order of these steps should be used when reassembling the machine. Before replacing the back panel check the machine for leaks and make sure you clean up any water or oil spilled on the floor.

The instructor will assign a machine or machines that have some of the problems discussed in this unit to be repaired.

A. Find and correct each of the following problems:

1. The water will not cut off.
2. The machine will not spin.
3. Leaks.

B. List the causes of the problems and the steps taken to eliminate them.

**MAJOR BLOCK** Major Appliance Repair **NAME** _____

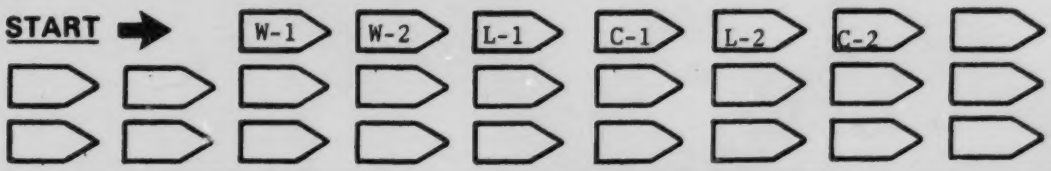
**TASK** Troubleshooting Electric Dryer

**UNIT** Servicing Dryer Mechanical and Air Systems **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-16

**OBJECTIVE(S)**

Identify components and troubleshoot the mechanical system of an automatic clothes dryer.




**WRITTEN ASSIGNMENT(S)**

| | |
|---|---|
| W-1 | Information Sheet MA-16a |
| W-2 | Information Sheet MA-16b |
| W-3 | |
| W-4 | |
| W-5 | |
| W-6 | |
| W-7 | |

**AUDIOVISUAL(S)**

| | |
|---|---|
| A-1 | |
| A-2 | |
| A-3 | |
| A-4 | |
| A-5 | |
| A-6 | |
| A-7 | |

**LABORATORY ASSIGNMENT(S)**

| | |
|---|---|
| L-1 | Job Sheet MA-16a |
| L-2 | Job Sheet MA-16b |
| L-3 | |
| L-4 | |
| L-5 | |
| L-6 | |
| L-7 | |
| L-8 | |
| L-9 | |

**CHECKPOINT(S)**

| | |
|---|---|
| C-1 | Instructor Check |
| C-2 | Instructor Check |
| C-3 | |
| C-4 | |
| C-5 | |
| C-6 | |
| C-7 | |
| C-8 | |
| C-9 | |

The functions of the mechanical system on a dryer are simple and usually to find a problem one only has to listen, look or feel. The drum has only one function, that is to tumble the clothes. As the belt turns the drum the baffles in the drum left the clothes and allows them to drop when they get close to the top (Figure A).

The dryer belt's function is to turn the drum. Most likely if the drum will not turn the belt has broken or slipped off. On most of the newer dryers only one belt is used. It goes around the drum, motor pulley and an idler pulley.

The idler pulley is used to hold tension on the belt. It can be mounted on a spring or be held in place by a spring (Figure B).

There are a few other mechanical arts such as: (1) Drum support rollers - used to support the rear of the drum; (2) Front bearing assembly and bearing ring - around the front drum opening and door opening; (3) Door hinges and catches. Catches are used to hold the door closed. The most practical troubleshooting procedure is to visually inspect parts. Listen to the operation and touch and feel the parts to check for wear.

For normal operation of the temperature control and safety systems, proper air flow through the dryer is essential. Air is pulled in from the lower front portion of the cabinet and up across the dryer heaters which are located behind the drum of the heat diffuser. The hot air moves into the drum and across the clothes. It then moves through the lint trap and down the trap duct into the blower. From here the air is forced out of the exhaust vent. (See Figure A).

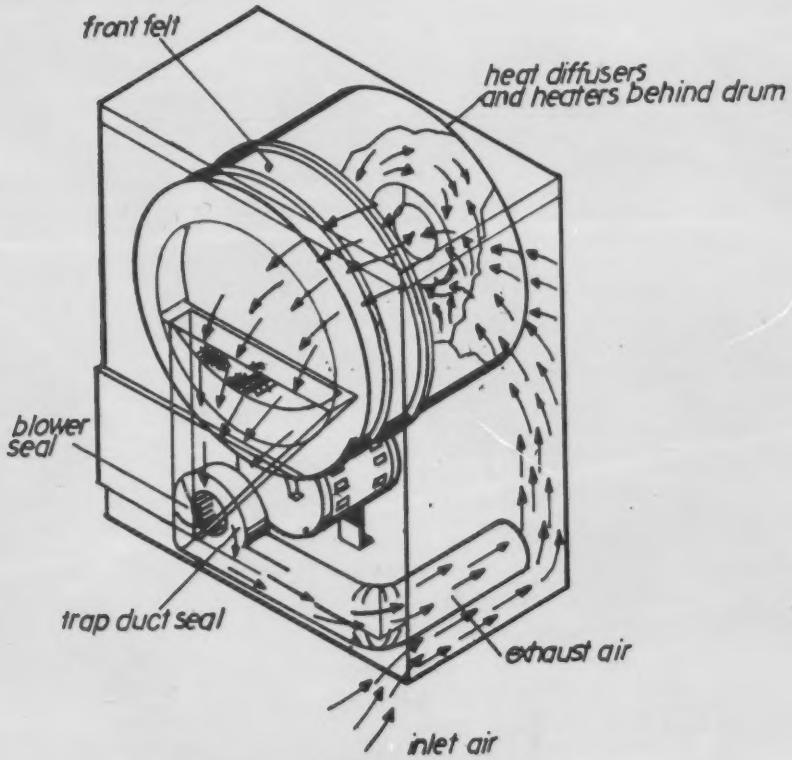



FIGURE A

Any air leaks between the air inlet and the blower such as heat diffuser, front drum felt, or trap duct to cabinet front sealing will result in improper temperature. The air being pulled down the trap duct across the drum outlet thermostat will be cooler than normal, giving this thermostat a false indication (delayed or no-trip). Leaks ahead of the blower will also reduce the volume of air across the heaters causing hot spots and possible premature failure.

The trap duct should be inspected for proper sealing. To do this the front of the dryer must be removed. Use a light to shine into lint trap duct from the drum side of the front assembly. Holes or voids in the seal will show up. If leaks are detected they should be sealed with permagum.

If flexible duct is needed the metal type usually has the best results. Cutting will not usually be necessary unless the duct area is less than a few inches. Special care should be taken to securely fasten the flexible duct to the exhaust outlet of the dryer.

Belt tension is maintained by a spring loaded idler pulley and driven by a pulley attached to the rear motor shaft. The drum rotates counter-clockwise when viewed from the front and turns at a speed of 47-50 rpm, (See Figure B).

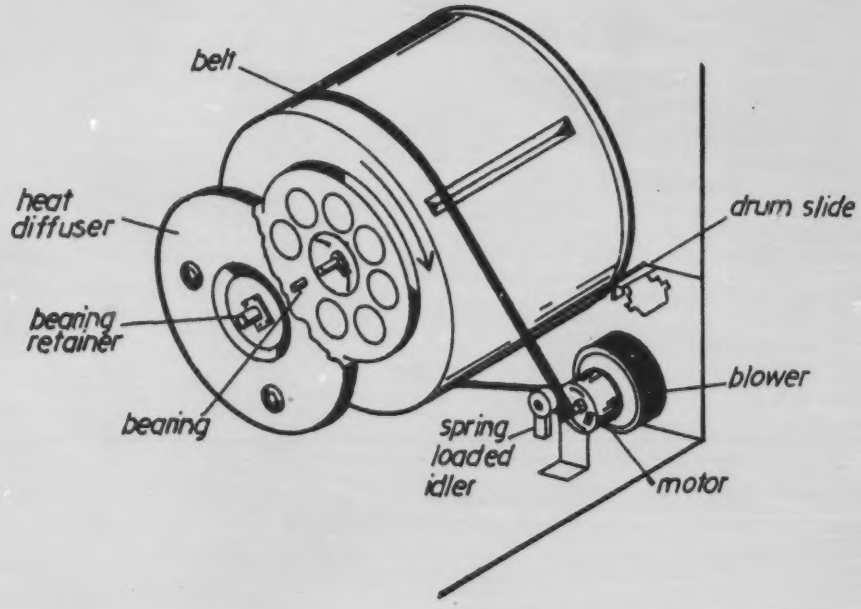



FIGURE B

The instructor will assign an automatic clothes dryer to disassemble, identify and label all parts, reassemble. Follow the procedures below to complete this activity:

1. Remove the timer and control panel components. Their are three screws across the top of the panel front (Refer to Figure 1).

2. Lift up and forward and lay the panel on the dryer top. Mark the wires and disconnect them (actually the wires should be labeled). Most of these timers are mounted on a bracket which is attached to the control panel front.

3. Remove the four phillips screws across the top of the door opening. This will release the dryer top.

4. Remove the front of the dryer (Refer to Figure 3). There are four quarter inch hex head screws holding the front at the top. At the bottom there are 2-5/16 inch hex head screws; one on each side. When these are removed the front can be lifted up and off the dryer.

5. From the back of the dryer (Refer to Figure 4) remove the holding ring on the drum shaft. Pull the drum up and out of the cabinet.

6. When the drum has been removed locate a hole at the top of the blower compartment (Refer to Figure 5). If the hole is not visible in the housing then the housing face should be removed. If the hole is visible a long allen wrench will be needed. Place one hand inside the intake duct from the front of the dryer and find the hole where the set screw is located. Insert the allen wrench and remove the screw.

7. Remove the blower housing cover by loosening a 5/16" hex head screw on the blower. Remove this and the blower will slide off the shaft.

8. Label each of the parts and ask the instructor to examine the parts.

9. Replace each of the parts in the exact reverse order. Make sure that all parts are securely fastened and all screws have been tightened.

FIG. 1

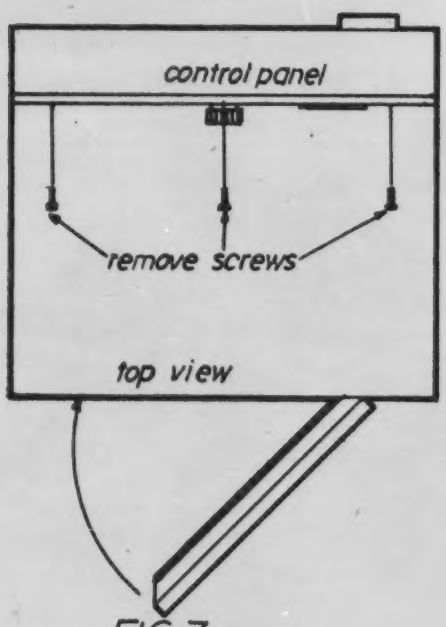



FIG. 2

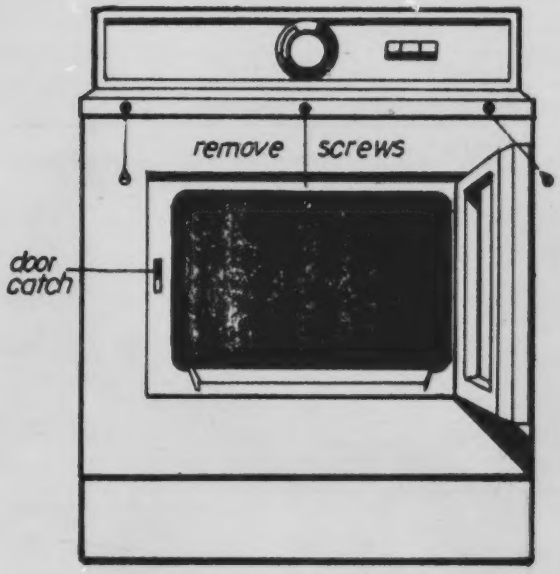



FIG. 3

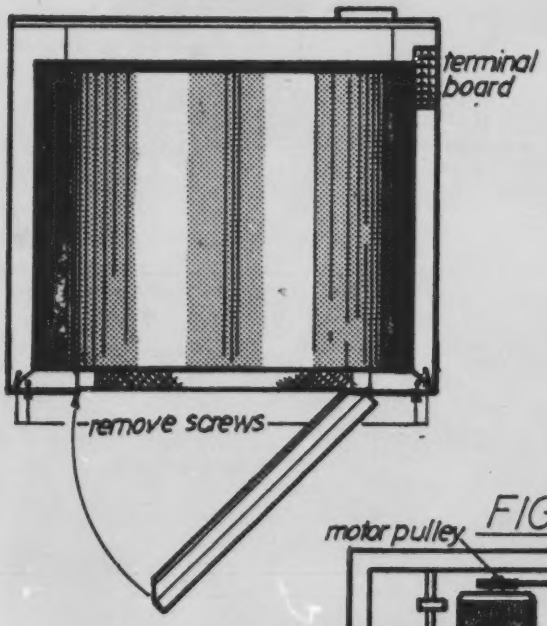



FIG. 4

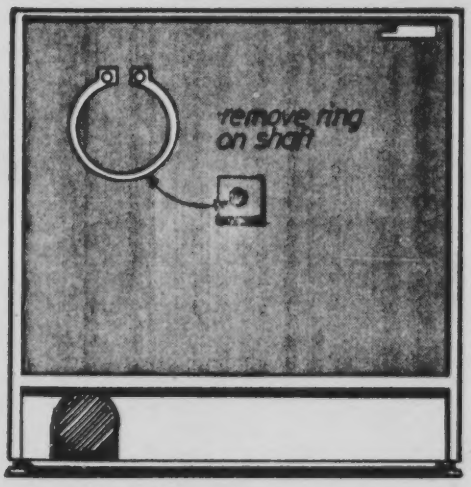
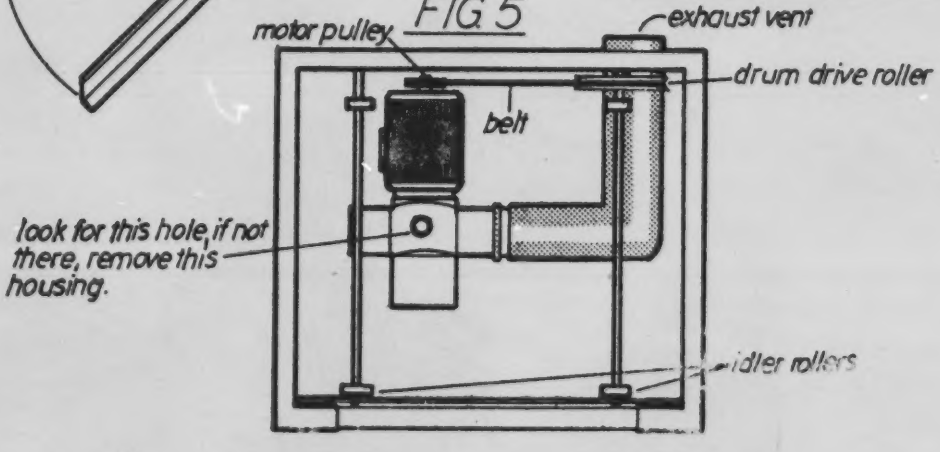



FIG. 5



1. The instructor will assign a dryer for this activity.
2. Refer back to the previous information sheet.
3. The dryer may have as many as three mechanical and air system problems.
4. Find the problems and make the necessary repairs or adjustments.
5. Clean up your work area and return your tools to their proper location.

**MAJOR BLOCK** Major Appliance **NAME** _____

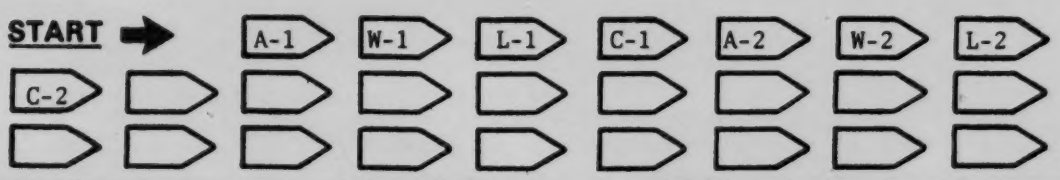
**TASK** Troubleshooting Electric Dryers

**UNIT** Servicing Dryer Electrical System **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-17

**OBJECTIVE(S)**

Diagnose and repair electrical problems in an automatic clothes dryer.




**WRITTEN ASSIGNMENT(S)**

| | |
|---|---|
| W-1 | Information Sheet MA-17a |
| W-2 | Information Sheet MA-17b |
| W-3 | |
| W-4 | |
| W-5 | |
| W-6 | |
| W-7 | |

**AUDIOVISUAL(S)**

| | |
|---|---|
| A-1 | Slide Set MA-17a |
| A-2 | Slide Set MA-17b |
| A-3 | |
| A-4 | |
| A-5 | |
| A-6 | |
| A-7 | |

**LABORATORY ASSIGNMENT(S)**

| | |
|---|---|
| L-1 | Job Sheet MA-17a |
| L-2 | Job Sheet MA-17b |
| L-3 | |
| L-4 | |
| L-5 | |
| L-6 | |
| L-7 | |
| L-8 | |
| L-9 | |

**CHECKPOINT(S)**

| | |
|---|---|
| C-1 | Instructor Check |
| C-2 | Instructor Check |
| C-3 | |
| C-4 | |
| C-5 | |
| C-6 | |
| C-7 | |
| C-8 | |
| C-9 | |

All dryers have a motor, a timer, at least two thermostats, at least one heating element and a safety door switch. The purpose for each of these components will be described below.

1. The motor in the electric dryer is usually rated at 1/3 horsepower and operates of 1.725 RP.M.

2. The timer controls the cycle length and the functions of the dryer.

Most dryers have two cycles, one for drying and one for air flufing. In addition, modern dryers have an extra cycle for permanent press clothing since permanent press fabrics usually require a lower drying temperature.

The thermostats and heating elements are used for producing and maintaining a certain level of heat. One of the thermostats is for controlling the temperature, and the other is a safety device used to keep the dryer temperature down in order to prevent damage to clothing should the controlling thermostat fail to shut the heat off.

The primary use of the door switch is to stop the motor when the door is opened. Secondly, the switch may be used to turn on a light inside the drum when the door is opened.

When a timer is set for drying, timer contacts Y to BG, Y to R to BR to RE are closed. When the "push to start" switch is pressed, contacts R1 to R2 are closed which energizes the relay coil holding the set of contacts closed.

When the motor reaches 75% of full speed, the switch opens up in the direction of the dashed line arrow (see figure A) cutting the start winding off and lowering the amperage and increasing the speed of rotation. At the same time switch 1N to 2N closes, creating a path for current flow through the heater as shown by the dotted arrows. The path for the motor circuit is shown by the solid arrows.

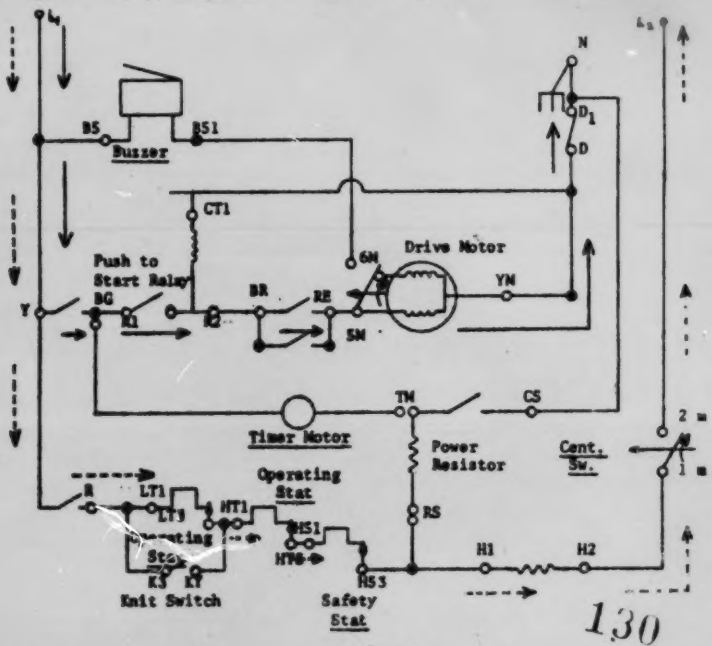



FIGURE A

The instructor will assign a clothes dryer to be disassembled. Use the following procedures:

1. Remove the electrical parts.
2. Label each part.
3. Describe the function of each part.
4. Get the instructor to check your work.
5. Reassemble the dryer.
6. Get the instructor to check the wiring to make sure it has been put back in the right place.
7. Return tools to their proper location and clean up the work area.

| CUSTOMER COMPLAINT | CAUSE | REMEDY |
|---|---|---|
| Won't Run | fuses | replace fuse |
| | unplugged | plug it up |
| | faulty wiring | repair or replace |
| | timer | replace |
| | door switch | replace |
| | push to start | replace |
| | drive motor | replace |
| | motor switch | replace |
| No Heat | fuse | replace |
| | wiring | repair or replace |
| | motor switch | replace |
| | heater | replace |
| | thermostat | replace |
| | timer | replace |
| Not Enough Heat | thermostat | replace |
| | timer | replace |
| Timer Won't Advance | timer motor | replace |
| | wiring | repair or replace |

FIGURE B

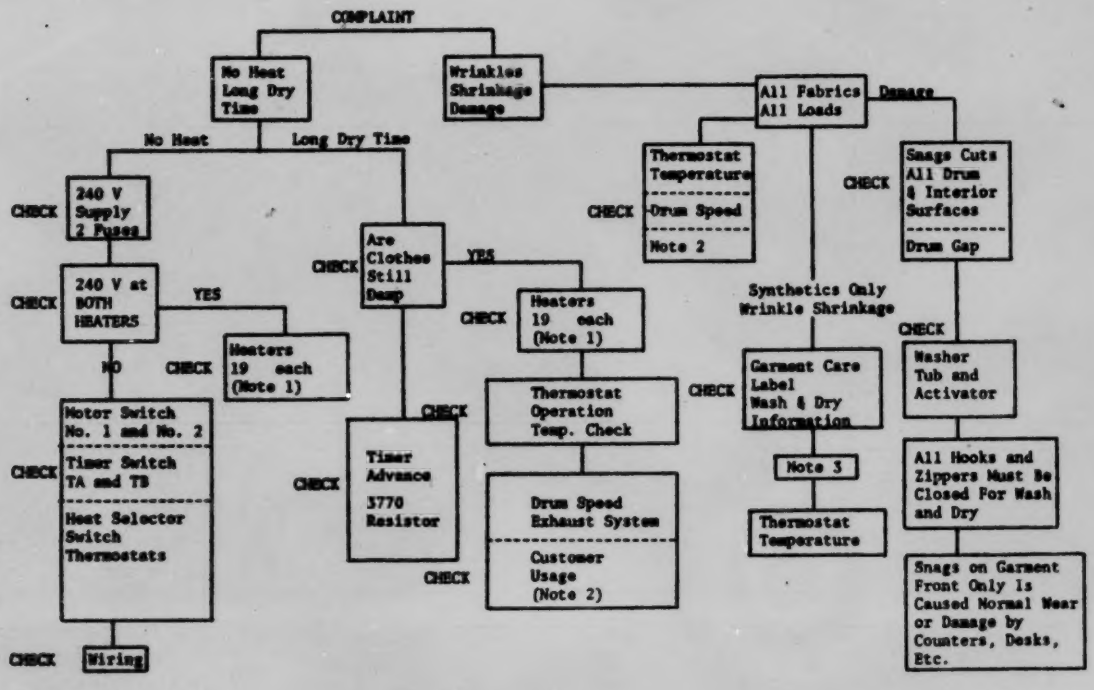



FIGURE C

The instructor will assign at least two dryers on which problems should be diagnosed and repaired.

**MAJOR BLOCK** Servicing Major Appliances **NAME** _____

**TASK** Troubleshooting Automatic Dishwashers

**UNIT** Testing and Replacing Solenoids **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-18

**OBJECTIVE(S)**

Test and replace the solenoid on the soap dispenser and the fill valve of an automatic dishwasher.

**START** → W-1 W-2 C-1 A-1 L-1 C-2

**WRITTEN ASSIGNMENT(S)**

W-1 Information Sheet MA-18a
W-2 Assignment Sheet MA-18a
W-3 _____
W-4 _____
W-5 _____
W-6 _____
W-7 _____

**AUDIOVISUAL(S)**

A-1 Slide Set MA-18a
A-2 _____
A-3 _____
A-4 _____
A-5 _____
A-6 _____
A-7 _____

**LABORATORY ASSIGNMENT(S)**

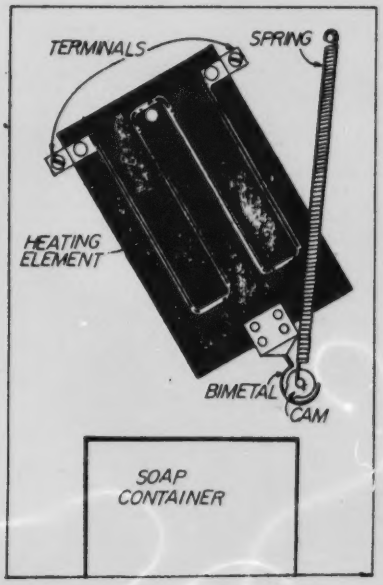
L-1 Job Sheet MA-18a
L-2 _____
L-3 _____
L-4 _____
L-5 _____
L-6 _____
L-7 _____
L-8 _____
L-9 _____

**CHECKPOINT(S)**

C-1 Instructor Check
C-2 Instructor Check
C-3 _____
C-4 _____
C-5 _____
C-6 _____
C-7 _____
C-8 _____
C-9 _____

There are usually two solenoids found on the automatic dishwasher.. One is a solenoid switch on the soap dispenser and the second is a solenoid valve controlling the amount of water entering the machine. Both of these valves are controlled by the timer. As the soap dispenser solenoid is energized the plunger of the armature is lifted and soap is released into the machine. Some manufacturers use a bimetal control switch which when heated releases the spring loaded door and releases the soap (Figure A). Whether the solenoid or bimetal control is used the soap dispenser only engages for a short period of time until the soap is released and the switch is immediately disengaged.

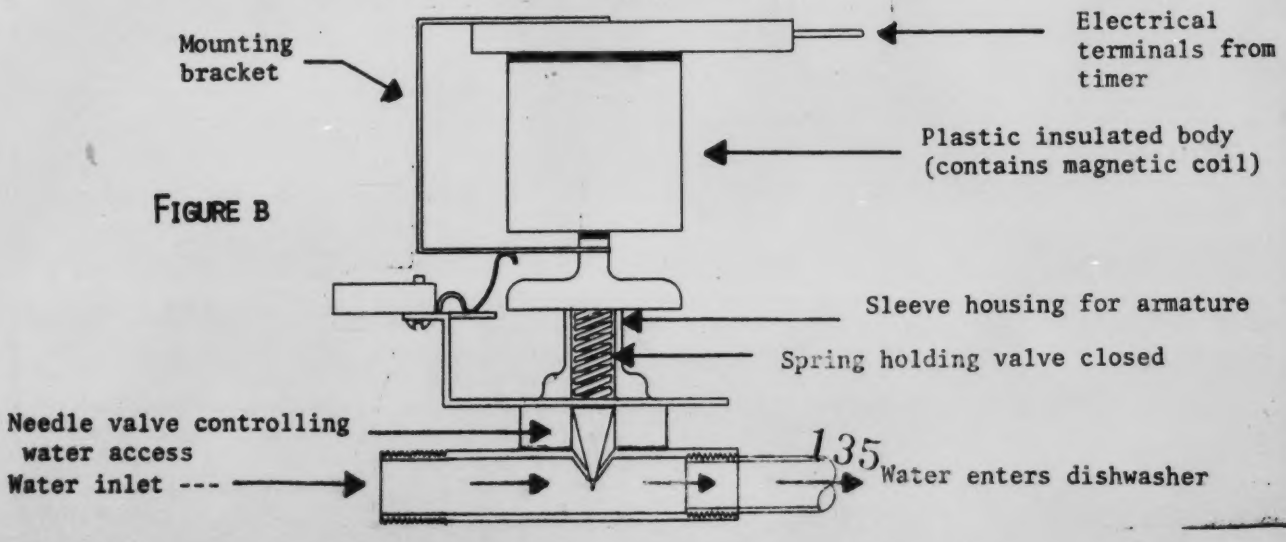
FIGURE A




Problems in the soap dispenser may exist when the heating element of the bimetal control overheats or the solenoid does not turn off immediately when soap is released.

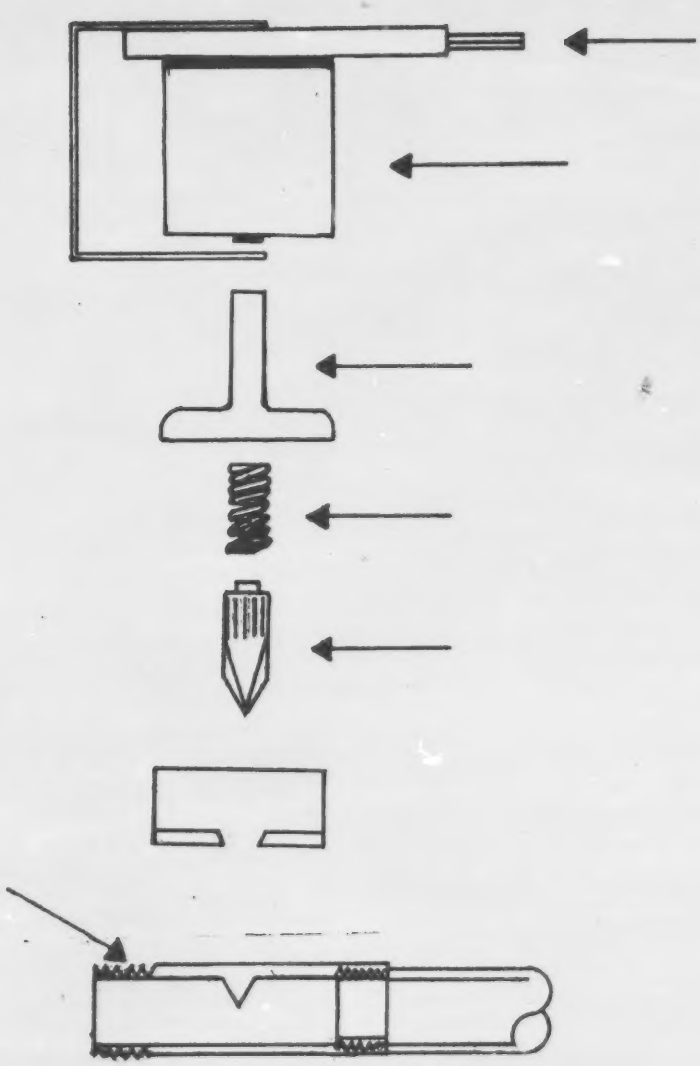
The dishwasher is supplied only when hot water is released into the machine by a solenoid controlled fill valve. On a signal from the timer the solenoid engages and opens the fill valve releasing water into the dishwasher.

FIGURE B



To test the solenoid and the bimetal control switch the terminals of the devices should be checked for good continuity. Voltage may also be checked at the terminals when the machine is in operation. The solenoid, however, will not be engaged except when the timer has reached the water fill position during rotation.

The following is an exploded view of a solenoid fill valve from an automatic dishwasher. Identify each component and give a brief description of its function within the dishwasher.



The instructor will assign a dishwasher on which the soap dispenser solenoid and the solenoid fill valve can be tested and replaced. Use the procedure below on each of the components.

PROCEDURES:

1. Locate the solenoid. (The controls on the dispenser may sometimes be of the bimetal control type. If this is the case checking and replacement will usually be the same).

2. Check continuity of the terminals. Some resistance should exist otherwise the coils of the solenoid may be broken.

3. Check the voltage of the terminals. The solenoid switch or valve will not register any voltage unless the timer is in the appropriate position. Manually turn the timer to the position where the solenoid should be engaged. If no voltage is apparent at the appropriate position in the cycle the solenoid may be malfunctioning.

4. Remove the screws supporting the solenoid to the body of the machine and replace the device.

5. Use the VOM to retest the solenoid.

6. Replace all components and operate the machine.

**MAJOR BLOCK** Major Appliance **NAME** _____

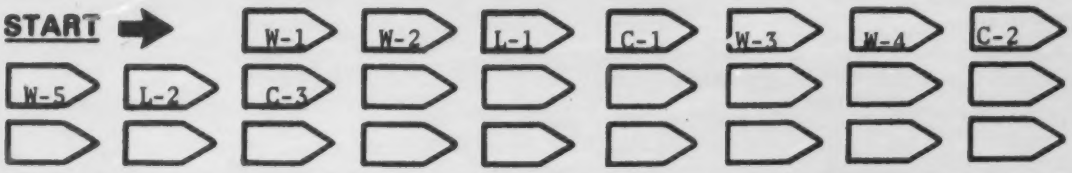
**TASK** Troubleshooting Automatic Dishwasher

**UNIT** Checking water level control and replacing door switch **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-19

**OBJECTIVE(S)**

Check the water level control and replace the door switch on an automatic dishwasher.




**WRITTEN ASSIGNMENT(S)**

**W-1** Information Sheet MA-19a
**W-2** Information Sheet MA-19b
**W-3** Information Sheet MA-19c
**W-4** Assignment Sheet MA-19a
**W-5** Information Sheet MA-19d
**W-6** _____
**W-7** _____

**AUDIOVISUAL(S)**

**A-1** _____
**A-2** _____
**A-3** _____
**A-4** _____
**A-5** _____
**A-6** _____
**A-7** _____

**LABORATORY ASSIGNMENT(S)**

**L-1** Job Sheet MA-19a
**L-2** Job Sheet MA-19b
**L-3** _____
**L-4** _____
**L-5** _____
**L-6** _____
**L-7** _____
**L-8** _____
**L-9** _____

**CHECKPOINT(S)**

**C-1** Instructor Check
**C-2** Instructor Check
**C-3** Instructor Check
**C-4** _____
**C-5** _____
**C-6** _____
**C-7** _____
**C-8** _____
**C-9** _____

The safety door switch is designed to break the power to the machine, stopping it when the door is open. The switch on most models is a single pole single throw (SPST) switch in series with the incoming power.

The switch is mounted on and activated by the door latch assembly which is located in the center upper portion of the machine door housing.

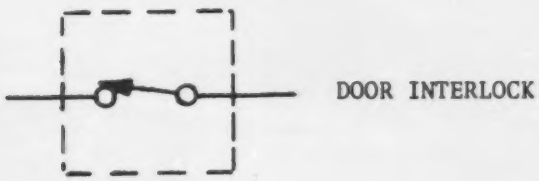



FIGURE A

SPST Switch

This is a dishwasher wiring diagram using the safety door switch.

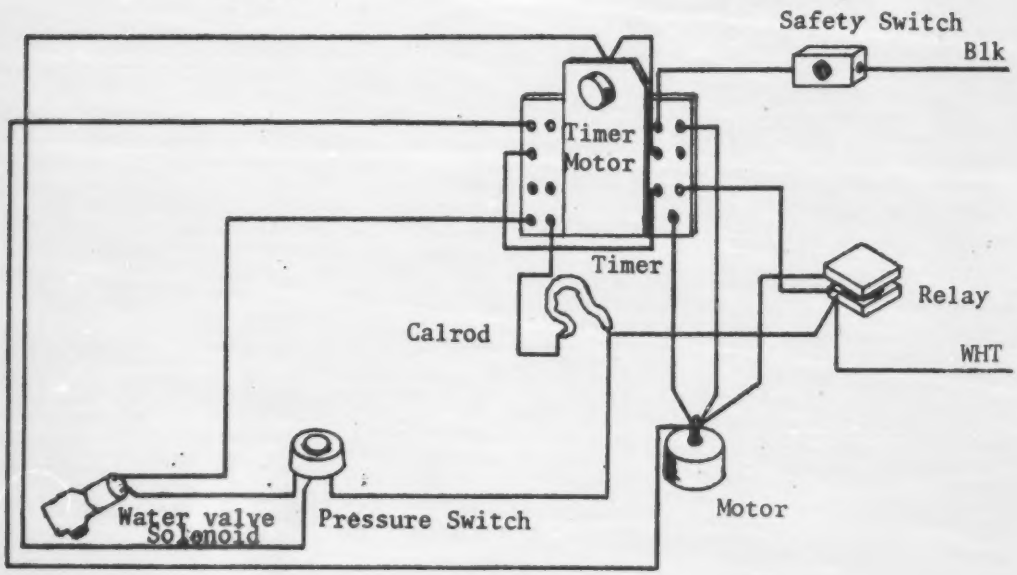


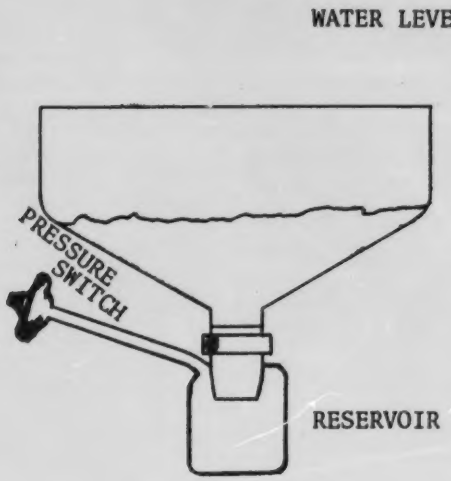



FIGURE B

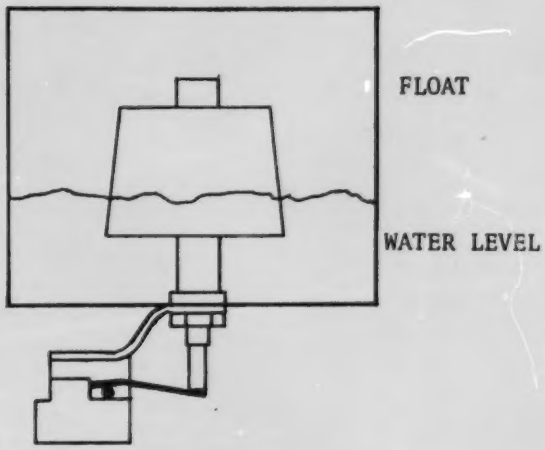
To test a safety door switch, an ohmmeter is needed. To get to the switch on a dishwasher refer to its service manual for instructions on removing the necessary panels. To test the switch the power should be off and the wires disconnected from the switch. With the latch in the lock position, test with the ohmmeter across the two terminals. There should be continuity through the switch. If there is no continuity the switch is either bad or the latch is not activating it properly. If the switch is bad it must be replaced. If the latch is not activating the switch this must be adjusted.

Secure the proper service manual, go to the dishwasher assigned by the instructor and remove the necessary panels to reveal the safety door switch. Work the latch and note how the switch is actuated. Test the switch for continuity. Have the instructor check work as it is being performed to insure correct procedures are followed.

The purpose of a water level control switch is to limit the amount of water allowed into the tub. This switch is a safety to keep the dishwasher from flooding. The switch is in series with the water valve. It is either actuated by the pressure from the weight of the water in the tub or by a float type switch that is activated by the water level. The service manual for the model will explain which type of switch the unit has. The drawings below give more detail.

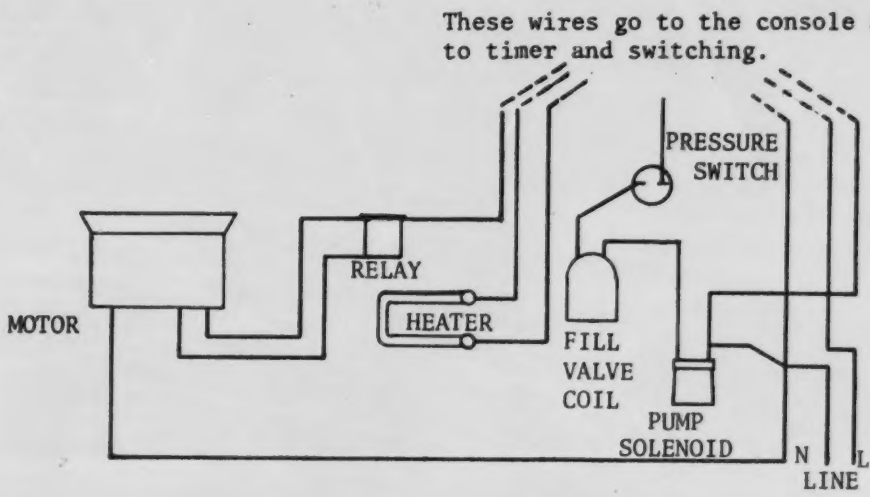



This is one type of pressure actuated water level control switch.




FLOAT SWITCH

This is a water level control switch using a Float design.




This diagram shows the pressure type water level switching series with the fill solenoid

FIGURE C

1. What is the purpose for the water level control switch?
2. What are the different types of water level control switches?
3. How does the water level switch affect the fill valve solenoids?
4. What is the purpose for a safety door switch?
5. Where is the safety door switch located on the dishwasher?

## Continuity Checking Procedures for Water Level Control Switches

### Float Type

The switch on this assembly is normally a SPST switch. To test it for continuity the power should be off. With the wires unplugged from the switch, the float still in place and no water in the machine, continuity through the switch should be present. Next remove the float from its float shaft and test the switch with the ohmmeter. There should be no reading.

### Pressure Type

Due to the variation in models of dishwashers and the different types of pressure actuated water level switches refer to the proper service manual for checking information. With the proper service manual go to a dishwasher and remove the toeplate or necessary panels to reveal the water level control switch. Check the switch for continuity then remove and replace the switch. The instructor should check work to make sure the correct procedures are being followed.

With the proper service manual go to a dishwasher and remove the toeplate on necessary panels to reveal the water level control switch. Check the switch for continuity, then remove and replace the switch. The instructor should check the work performed to insure proper procedures are followed.

**MAJOR BLOCK** Major Appliance **NAME** _____

**TASK** Troubleshooting Automatic Dishwashers

**UNIT** Checking and Replacing Heating Element on Dishwashers **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-20

**OBJECTIVE(S)**

Test and replace heating elements on an automatic dishwasher.

**WRITTEN ASSIGNMENT(S)**

**W-1** Information Sheet MA-20a
**W-2** Assignment Sheet MA-20a
**W-3** _____
**W-4** _____
**W-5** _____
**W-6** _____
**W-7** _____

**AUDIOVISUAL(S)**

**A-1** _____
**A-2** _____
**A-3** _____
**A-4** _____
**A-5** _____
**A-6** _____
**A-7** _____

**LABORATORY ASSIGNMENT(S)**

**L-1** Job Sheet MA-20a
**L-2** _____
**L-3** _____
**L-4** _____
**L-5** _____
**L-6** _____
**L-7** _____
**L-8** _____
**L-9** _____

**CHECKPOINT(S)**

**C-1** Instructor Check
**C-2** Instructor Check
**C-3** _____
**C-4** _____
**C-5** _____
**C-6** _____
**C-7** _____
**C-8** _____
**C-9** _____

## Introduction

The heating element in a dishwasher has only two functions: to heat water for washing, and air for speedier drying. The heater may be energized during the wash cycle or only part of the "dry" cycle depending on the model. Both are optional on later models since energy conservation is desired. The heater is a calrod type which has coiled wires called the helix in the center that produces heat when current flows through it. The helix is insulated from the sheath by an electrical insulation, normally magnesium oxide (Figure A).

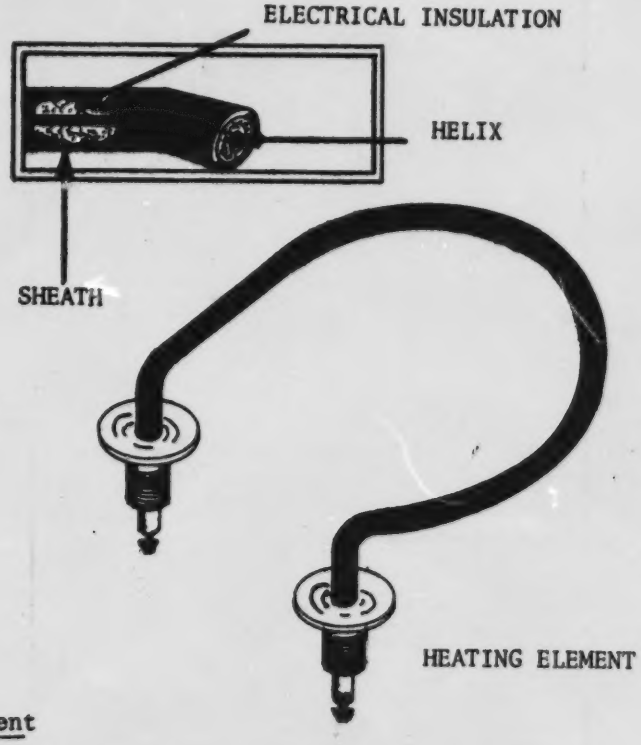



FIGURE A

## Testing the Element

Most heater elements have a range of 750 watts to 950 watts depending on the model. To test an element for continuity an ohmmeter is needed. To keep from burning the meter, the element power must be cut off and the wires unplugged. Place one test load on one element terminal and the other lead on the other terminal. There should be continuity throughout the unit. The resistance will vary according to the wattage ratings. If there is no reading the element is open. To test for a short circuit go from one of the element terminals to the outer sheath of the element. If there is a reading the element is shorted, if there is no reading the unit is good.

Removal Procedures

The heating element is formed along the bottom of the dishwasher floor according to the design of the machine. The element sticks through the floor and is fastened down by nuts to make a watertight seal. To remove the heating element, cut the incoming power off and remove the toeplate (refer to machine's manual). Unplug the wires from the heating element terminals and take the two nuts off. Remove the bottom shelf from the dishwasher and pull element up out of the floor and out of its holding clips (if any).

Explain orally to the instructor:

A. The purpose of the heating element.

B. Another name for the heating element

C. How to test the element.

Using the correct service manual go to the dishwasher assigned by the instructor and test the heating element for continuity. Next, remove the unit from the dishwasher and re-install it. Have the instructor check the procedure used in checking, removing, and re-installing the heating element.

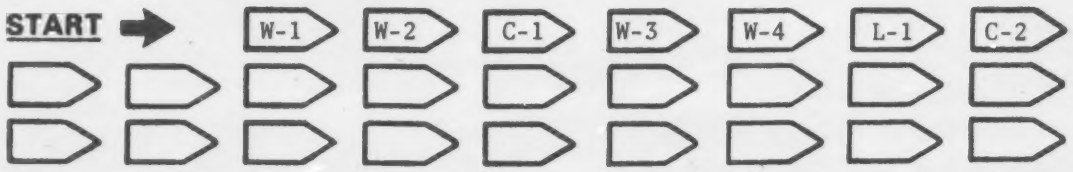
**MAJOR BLOCK** Major Appliance **NAME** _____

**TASK** Troubleshooting Automatic Dishwashers

**UNIT** Testing and Replacing Motor Relays **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-21

**OBJECTIVE(S)** Check and Replace Motor Relays




**WRITTEN ASSIGNMENT(S)**

W-1 Information Sheet MA-21a
W-2 Assignment Sheet MA-21a
W-3 Information Sheet MA-21b
W-4 Text Assignment MA-21a
W-5 _____
W-6 _____
W-7 _____

**AUDIOVISUAL(S)**

A-1 _____
A-2 _____
A-3 _____
A-4 _____
A-5 _____
A-6 _____
A-7 _____

**LABORATORY ASSIGNMENT(S)**

L-1 Job Sheet 21a
L-2 _____
L-3 _____
L-4 _____
L-5 _____
L-6 _____
L-7 _____
L-8 _____
L-9 _____

**CHECKPOINT(S)**

C-1 Instructor Check
C-2 Instructor Check
C-3 _____
C-4 _____
C-5 _____
C-6 _____
C-7 _____
C-8 _____
C-9 _____

The purpose for a motor relay is to energize and de-energize the start windings in the motor. Most relays are current-operated and are normally open until the locked-rotor current is drawn through the primary coil of the relay which is in series with the run windings. Current passing through an armature in the relay closes the starting contacts. As the motor starts running normally the current drops and the magnetism holding the armature isn't enough to keep the contacts closed, therefore, the start winding drops out of the circuit. All this takes place within 5 seconds. Figure A shows a schematic of a dishwasher relay wired to a reversible type motor.

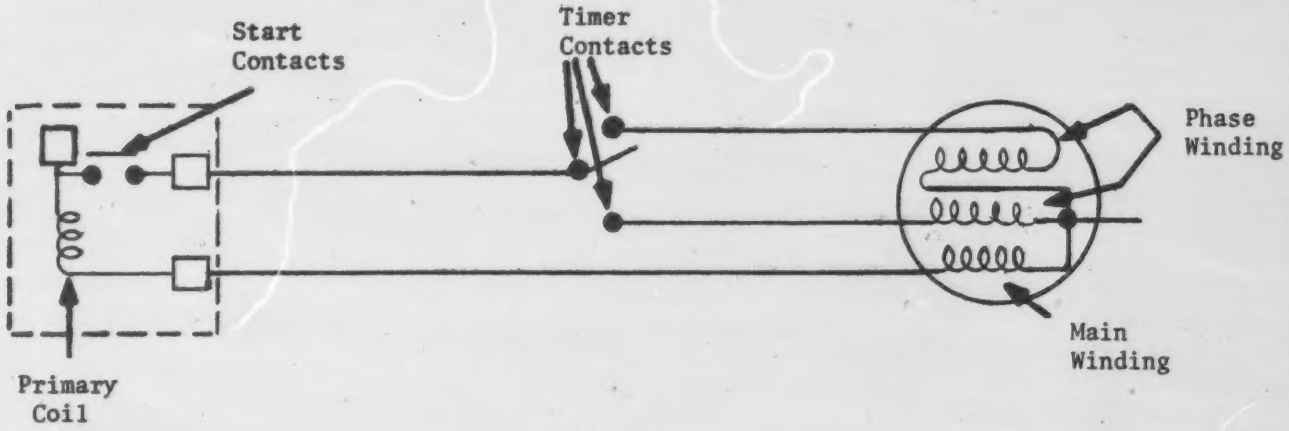



FIGURE A

The location of the relay varies on different models. Consult the proper service manual for location and the removal of necessary panels.

Look at the diagram below. Which part represents the motor? _____

_____

_____

_____

Which part represents the relay? _____

_____

_____

_____

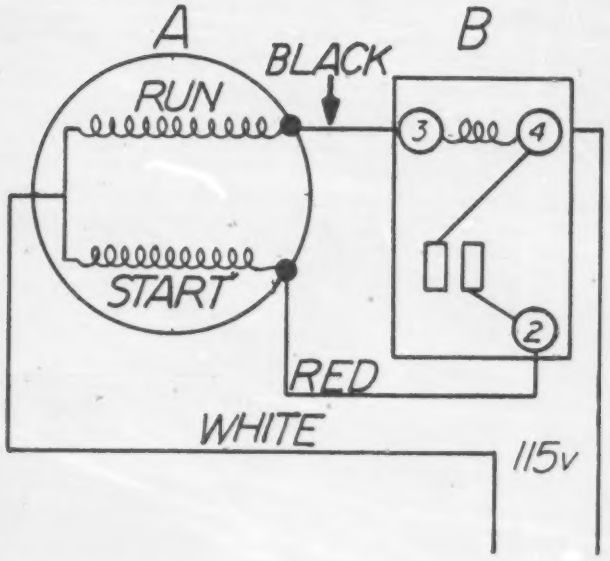



FIGURE B

The only continuity check for the current type relay on a dishwasher is a test of the primary coil. The relay's primary coil normally has both ends externally attached to two of the relay terminals. To test the coil, an ohmmeter is needed. With the meter, test from one of the terminals which has an end of the coil attached to it, to the other terminal with the opposite end of the coil attached to it. (Figure C). There should be a reading.

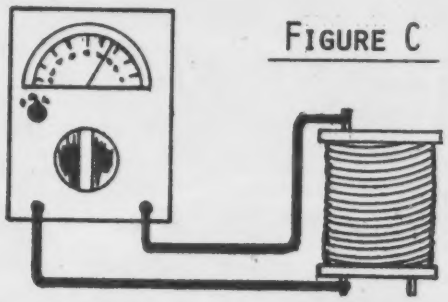


FIGURE C

If the relay contacts for the motor start winding will not close or the armature is defective, the motor will hum, but will not run. To test for the contacts not closing, jump out the contacts by hooking a jumper from an incoming power terminal to the third terminal for just a moment, then take it off after the motor starts to run. (Figure D)

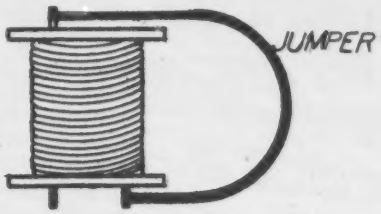



FIGURE D

If the contacts get stuck (closed in the relay) the motor will trip out on overload or burn out because of the heat exhausted by both the start and run windings. For the removal of the motor relay, consult the proper service manual for instructions.

With the proper service manual, go to a dishwasher, remove the necessary panel to get to the motor relay. Check the relay coil for continuity and operate the machine to check the contacts in the relay.

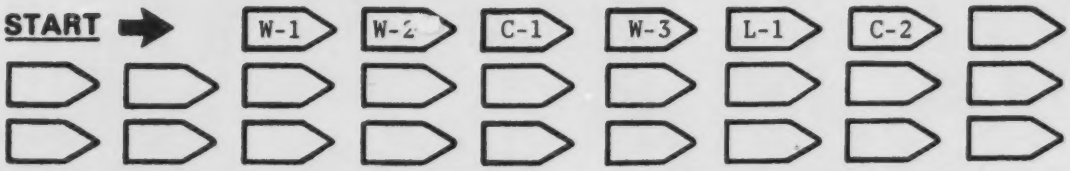
**MAJOR BLOCK** Major Appliances **NAME** _____

**TASK** Troubleshooting Automatic Dishwashers

**UNIT** Replacing automatic dispenser **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-22

**OBJECTIVE(S)** Replace and check automatic dispenser on dishwasher




**WRITTEN ASSIGNMENT(S)**

**W-1** Information Sheet MA-22a
**W-2** Assignment Sheet MA-22a
**W-3** Information Sheet MA-22b
**W-4** _____
**W-5** _____
**W-6** _____
**W-7** _____

**AUDIOVISUAL(S)**

**A-1** _____
**A-2** _____
**A-3** _____
**A-4** _____
**A-5** _____
**A-6** _____
**A-7** _____

**LABORATORY ASSIGNMENT(S)**

**L-1** Job Sheet MA-22a
**L-2** _____
**L-3** _____
**L-4** _____
**L-5** _____
**L-6** _____
**L-7** _____
**L-8** _____
**L-9** _____

**CHECKPOINT(S)**

**C-1** Instructor Check
**C-2** Instructor Check
**C-3** _____
**C-4** _____
**C-5** _____
**C-6** _____
**C-7** _____
**C-8** _____
**C-9** _____

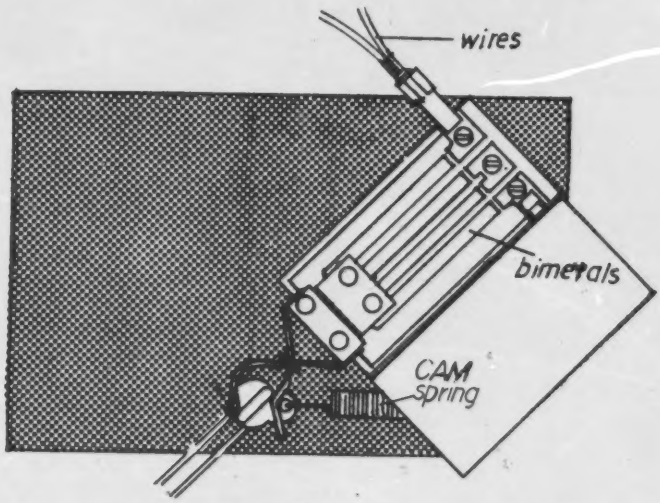
The detergent dispenser which is operated by a linkage from the timer does the same thing as the bimetal type does but it is activated by the timer cam.

The location of the detergent dispenser is in the inner door panel toward the upper half of the door.

The optional wetting agent dispenser is designed to add about a half centimeter of liquid wetting agent in the final rinse that causes water to drain from the dishes, thereby eliminating "spotting" that occurs from the drying of water drops. The dispenser uses a solenoid to pull back a plunger to allow the necessary amount of wetting agent to enter the tub. The solenoids power is supplied by the timer. The location of this dispenser varies with different models so consult the proper service manual for location.

On a dishwasher there are two types of dispensers, one is a soap dispenser which automatically adds detergent to the wash cycle and the second is a wetting agent dispenser. The detergent dispenser is bimetal or linkage operated. The bimetal, which is the most common, is energized by the timer at the beginning of the wash cycle, (see figure A). When voltage is applied to the bimetal strip it heats up and warps. This action causes the spring loaded detergent cup door to open. The bimetal must not be subjected to direct voltage so it is wired in series with the heater.

The bimetal assembly is located between the inner and outerdoor panels and mounted on the inner door panel behind the detergent dispenser.




This is a typical design of a bimetal controlled automatic detergent dispenser electrical circuit.

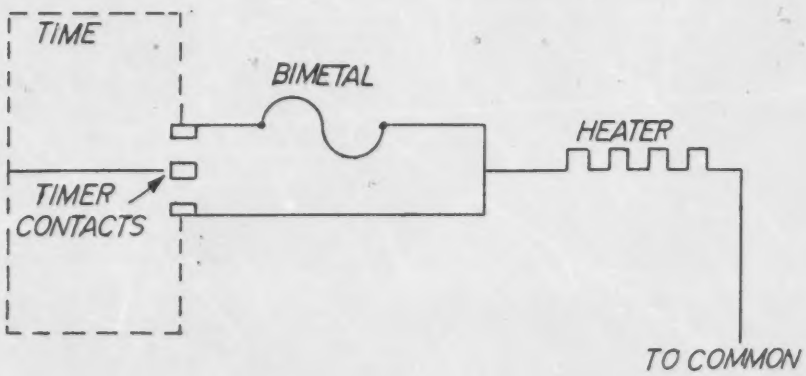



FIGURE B

1. What is the purpose for a detergent dispenser?

2. What is the purpose of a wetting agent dispenser?

3. What are the ways the detergent dispenser is activated? Explain how they work.

The only mechanical and electrical checks on a detergent dispenser are (1) check the bimetal for proper warping action against the cam or check the linkage for proper movement from the timer cam (depending on which is in use). (2) check the dispenser door for proper sealing and if it opens correctly.

To check the bimetal for correct operation operate the machine on either single or double wash to check if the bimetal will warp knocking down the cam properly. If the bimetal bends but doesn't bend enough to activate the cam, loosen the adjustment screw and adjust the bimetal support the needed amount. If it doesn't bend any, run it back through the beginning of a wash cycle and with a volt meter test the bimetal to see if it is energized at the beginning of the cycle. If it has power on it and doesn't bend it is bad.

To check the dispenser for proper sealing put some detergent in the detergent cup and run the machine on a double wash. At the end of the first wash, open the door to the dispenser and all the detergent put in should still be present.

Due to the different styles and designs of detergent dispensers refer to the proper service manual for removal.

To check the linkages operating detergent dispenser, operate the machine through a wash and check the linkage moved by the timer cam. Because of the difference in timers and the designs of the dispensers refer to the proper service manual for adjusting and removal of the dispenser and its linkage.

To check a wetting agent dispenser solenoid for continuity remove the necessary panels. Remove the wire from the solenoids and with an ohmmeter test across the two terminals. If there is a reading the solenoid is good. If there is no reading the solenoid is open. To test for liquid flow pull the plunger back in toward the solenoid and allow some liquid wetting agent to flow out. If it doesn't flow check to see if any liquid is in the container and make sure its path is not obstructed.

With the proper service manual go to a dishwasher check, remove and replace both the detergent dispenser and the wetting agent dispenser.

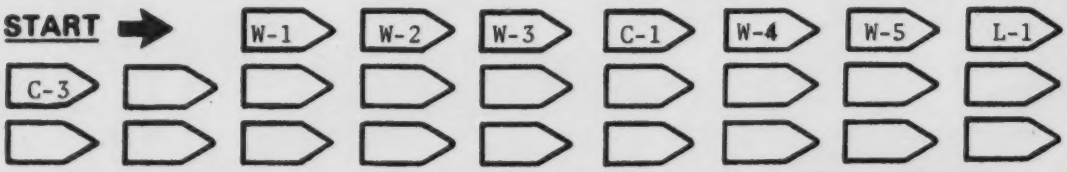
**MAJOR BLOCK** Major Appliance **NAME** _____

**TASK** Troubleshooting Automatic Dishwasher

**UNIT** Testing and Replacing Drain Pump **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-23

**OBJECTIVE(S)** Check and replace drain pumps on automatic dishwashers




**WRITTEN ASSIGNMENT(S)**

| | |
|---|---|
| W-1 | Information Sheet MA-23a |
| W-2 | Text Assignment MA-23a |
| W-3 | Assignment Sheet MA-23a |
| W-4 | Information Sheet MA-23b |
| W-5 | |
| W-6 | |
| W-7 | |

**AUDIOVISUAL(S)**

| | |
|---|---|
| A-1 | |
| A-2 | |
| A-3 | |
| A-4 | |
| A-5 | |
| A-6 | |
| A-7 | |

**LABORATORY ASSIGNMENT(S)**

| | |
|---|---|
| L-1 | Job Sheet MA-23a |
| L-2 | |
| L-3 | |
| L-4 | |
| L-5 | |
| L-6 | |
| L-7 | |
| L-8 | |
| L-9 | |

**CHECKPOINT(S)**

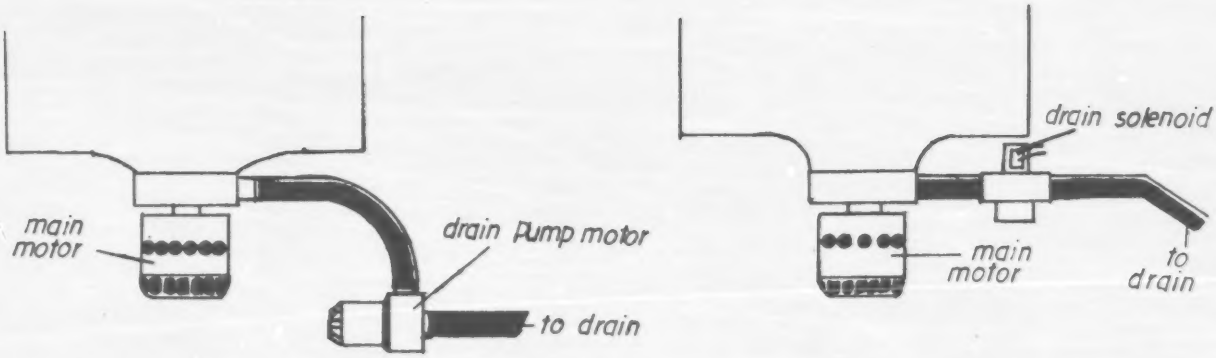
| | |
|---|---|
| C-1 | Instructor Check |
| C-2 | Instructor Check |
| C-3 | Instructor Check |
| C-4 | |
| C-5 | |
| C-6 | |
| C-7 | |
| C-8 | |
| C-9 | |

The drain pump is the device that pumps the water out of the dishwasher tub. It can be a separate motor, a solenoid operated gate driven by the main motor or a reversible type motor depending on the machine. If the drain system uses its main motor and no drain solenoid to pump the water out, the motor is a reversible type. The pump housing is specially designed so that the circulation of water in one direction keeps water from trying to go out the drain while it forces the water up spray tubes to do the washing. It then pumps the water out when it reverses.

The water can also be pumped out by a non-reversible main motor using a solenoid to open a gate allowing the water to be pumped out. The motor and drain solenoids are both energized by the timer.

The least common method of pumping water out of a dishwasher is the use of a separate motor which normally has around a 1/6 horsepower rating. This motor is energized by the timer when pump-out is desired.

Identify the type of drain system and explain its operation.




I. A. Type of Drain System _____

B. Explanation of Operation _____

_____

_____

_____

II. A. Type of Drain System _____

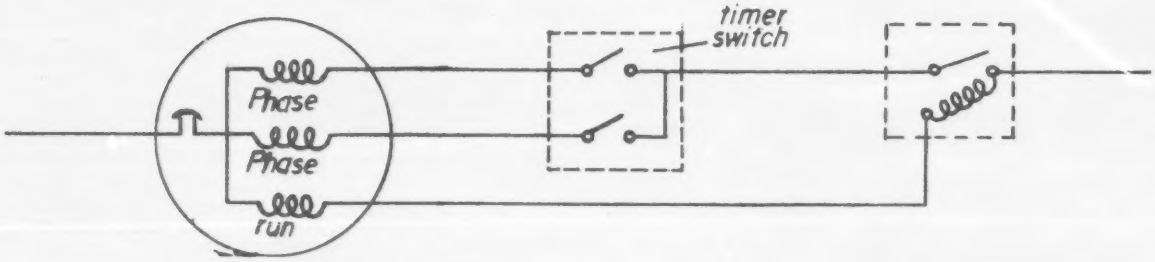
B. Explanation of Operation _____

_____

_____

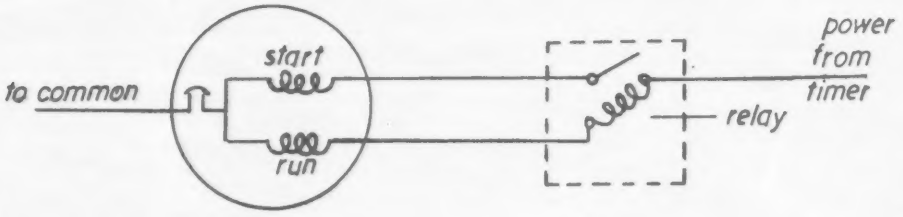
_____

To check the reversible type motor, make sure the motor shaft will rotate freely (there will be some drag in it because of the seal). To check the winding for continuity an ohmmeter is needed. Refer to the proper service manual for a schematic and color guide of the motor wires and check it accordingly.




This is a typical wiring diagram of a reversible type motor.

To check the non-reversible type pump motor, check and make sure that the motor shaft rotates freely (with a little drag from the seal). This motor has only 2 windings, a start and a run.




This is a wiring diagram of a non-reversible motor.

Refer to the proper service manual for color codes of the wires.

To check the non-reversible motor drain solenoid, remove the wire from it and check it for continuity. If there is no reading, the coil is open. If there is a reading, the coil is good.

To test a drain pump motor which is separate from the main motor, check to make sure that the motor shaft rotates freely and check it for continuity.

With the proper service manual, go to a dishwasher, remove the necessary panels and check the drain motor and solenoid (if used) for continuity; then remove and replace them.

Have the instructor check the progress of this job periodically.

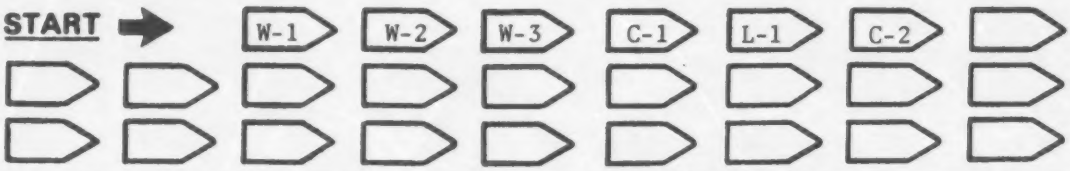
**MAJOR BLOCK** Major Appliances **NAME** _____

**TASK** Troubleshooting Automatic Dishwasher

**UNIT** Testing and Installing Timers **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-24

**OBJECTIVE(S)** Test and replace timer on automatic dishwasher.




**WRITTEN ASSIGNMENT(S)**

| | |
|---|---|
| W-1 | Information Sheet MA-24a |
| W-2 | Text Assignment MA-24a |
| W-3 | Assignment Sheet MA-24a |
| W-4 | |
| W-5 | |
| W-6 | |
| W-7 | |

**AUDIOVISUAL(S)**

| | |
|---|---|
| A-1 | |
| A-2 | |
| A-3 | |
| A-4 | |
| A-5 | |
| A-6 | |
| A-7 | |

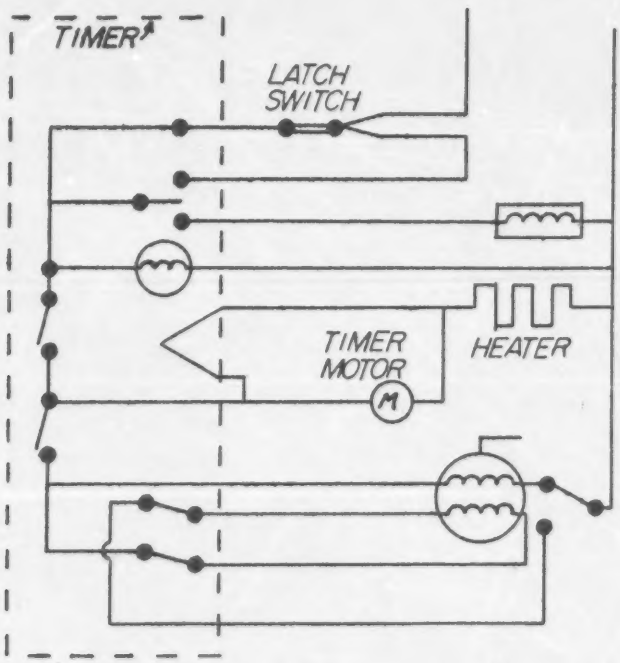
**LABORATORY ASSIGNMENT(S)**

| | |
|---|---|
| L-1 | Job Sheet MA-24a |
| L-2 | |
| L-3 | |
| L-4 | |
| L-5 | |
| L-6 | |
| L-7 | |
| L-8 | |
| L-9 | |

**CHECKPOINT(S)**

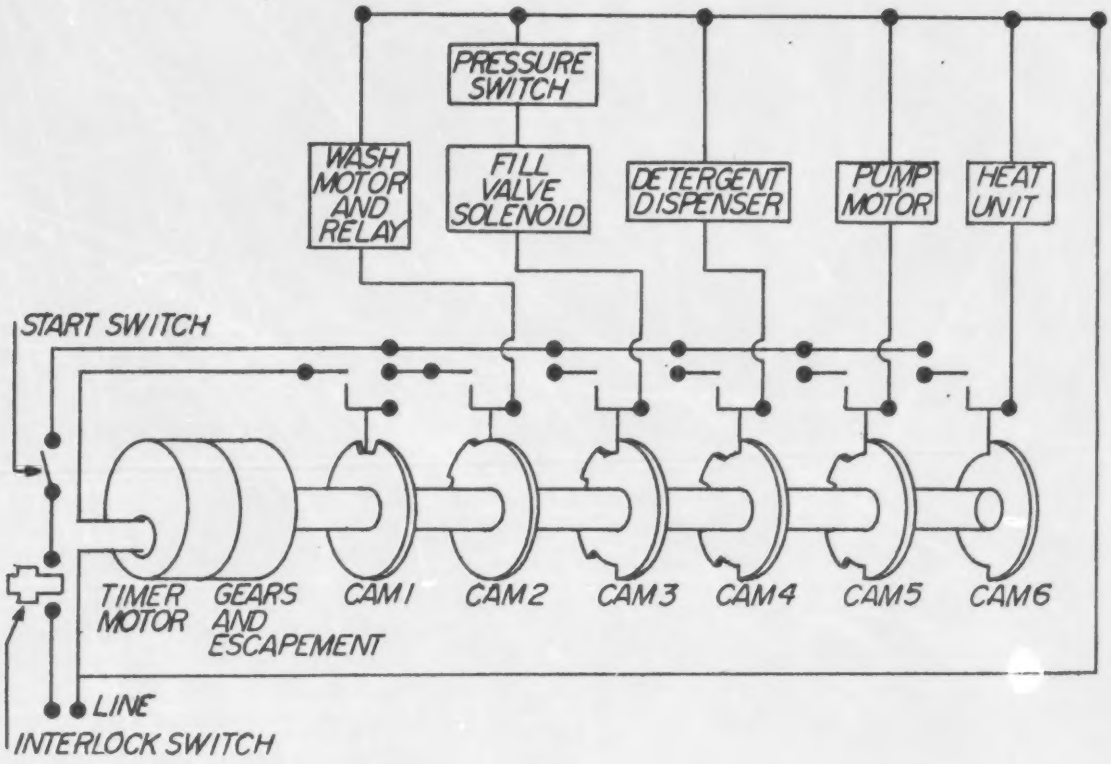
| | |
|---|---|
| C-1 | Instructor Check |
| C-2 | Instructor Check |
| C-3 | |
| C-4 | |
| C-5 | |
| C-6 | |
| C-7 | |
| C-8 | |

The timer is the brain of the whole dishwasher. It applies power to certain components of the dishwasher at a desired time. The timer is driven by a synchronized clock type motor. This motor turns an escapement which in turn drives the cam on the timer. The cam has paths that contacts follow, moving up and down depending on the lobes of the cam. Below is a schematic of a dishwasher showing the multitude of contacts the timer uses in controlling the dishwasher's functions.




Since timers on different dishwashers vary more than anything else, the only part which can be checked for sure is the timer motor. To test the motor for continuity, remove the leads from the timer terminals and test the motor for resistance. If there is no reading, the timer motor is bad. To check the contacts inside the timer, check the proper service manual for the contact making and breaking points.

Look at the functional diagram of a timer below:




What is the function of this timer motor?_____

_____

What is the function of the cam?_____

_____

_____

What does the start switch do?_____

_____

_____

With the proper repair manual, remove the necessary panels to reveal the timer. Test the timer motor and contacts, then remove and replace the timer.

**MAJOR BLOCK** Major Appliance **NAME** _____

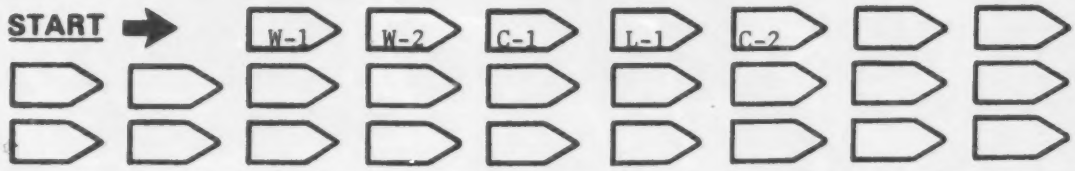
**TASK** Automatic Dishwashers

**UNIT** Diagnosing and Repairing Automatic Dishwasher **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-25

**OBJECTIVE(S)**

Diagnose and repair an automatic dishwasher.




**WRITTEN ASSIGNMENT(S)**

W-1 Text Assignment MA-25a
W-2 Assignment Sheet MA-25a
W-3
W-4
W-5
W-6
W-7

**AUDIOVISUAL(S)**

A-1
A-2
A-3
A-4
A-5
A-6
A-7

**LABORATORY ASSIGNMENT(S)**

L-1 Job Sheet MA-25a
L-2
L-3
L-4
L-5
L-6
L-7
L-8
L-9

**CHECKPOINT(S)**

C-1 Instructor Check
C-2 Instructor Check
C-3
C-4
C-5
C-6
C-7
C-8
C-9

Match the correct complaint with the correct possible cause.

| COMPLAINTS | POSSIBLE CAUSES |
|---|---|
| _____1. Dishwasher inoperative | a. Clogged drain screen |
| _____2. Main motor does not run | b. Open heater element |
| _____3. Dishwasher blows house fuse | c. Water temperature too low |
| _____4. Water will not enter tub | d. Impeller bent, broken or unbalanced |
| _____5. Incorrect water level | e. Defective drain valve |
| _____6. Water does not remain in tub | f. Open pressure switch |
| _____7. Water does not properly drain from tub | g. Defective fill valve or solenoid |
| _____8. Defective interlock or start switch | h. Defective interlock or start switch |
| _____9. Dishes not washed clean | i. Motor or impeller jammed |
| ____10. Dishes not dry | j. Defective starting relay or capacitor |

See the instructor for assignment to an automatic dishwasher to repair. The unit assigned will have been "bugged" by the instructor. Diagnose the problem and check with the instructor for an O.K. to make needed repairs. After the repair is made the instructor will make a final check.

**MAJOR BLOCK** Major Appliance **NAME** _____

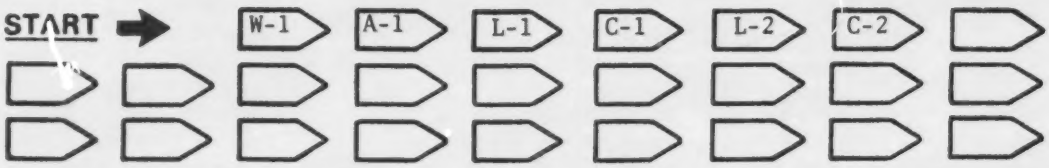
**TASK** Troubleshooting Electric Ranges

**UNIT** Test and Replace Surface Unit Element **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-26

**OBJECTIVE(S)**

Test and replace a surface unit element.




**WRITTEN ASSIGNMENT(S)**

| | |
|---|---|
| W-1 | Information Sheet MA-26a |
| W-2 | |
| W-3 | |
| W-4 | |
| W-5 | |
| W-6 | |
| W-7 | |

**AUDIOVISUAL(S)**

| | |
|---|---|
| A-1 | Slide Set MA-26a |
| A-2 | |
| A-3 | |
| A-4 | |
| A-5 | |
| A-6 | |
| A-7 | |

**LABORATORY ASSIGNMENT(S)**

| | |
|---|---|
| L-1 | Job Sheet MA-26a |
| L-2 | Job Sheet MA-26b |
| L-3 | |
| L-4 | |
| L-5 | |
| L-6 | |
| L-7 | |
| L-8 | |
| L-9 | |

**CHECKPOINT(S)**

| | |
|---|---|
| C-1 | Instructor Check |
| C-2 | Instructor Check |
| C-3 | |
| C-4 | |
| C-5 | |
| C-6 | |
| C-7 | |
| C-8 | |
| C-9 | |

There are two types of elements used in electric ranges, the open coil and closed rod. When the first electric range came into existence years ago, the surface units consisted of open coil elements wound on a porcelain form, called a brick. Later it was found that there were several disadvantages in using this type of element. One disadvantage was that the pots and pans placed on these units were not in direct contact with the heat itself. Air between the pan and element, caused a large amount of heat loss. Another disadvantage was the continuous damage done to the element by dropping pans or spilling water and food on them.

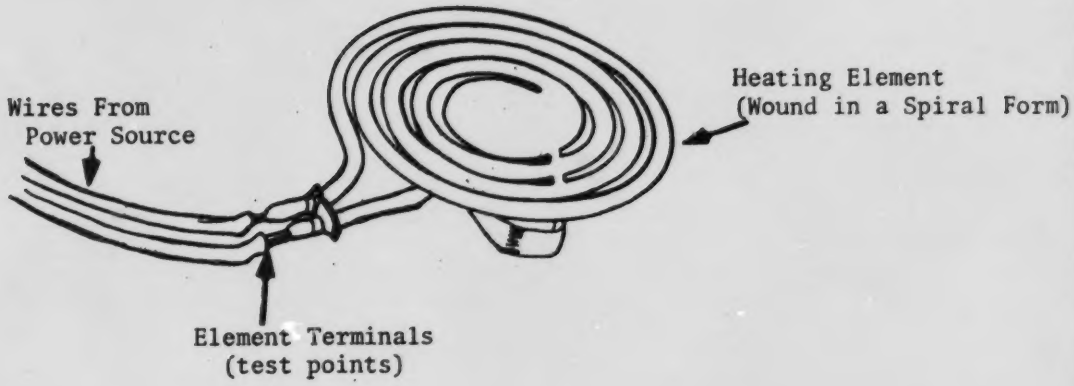
To solve these problems, the closed rod elements were introduced, (see Figure A). These elements are actually open coil elements placed inside a metal tube and embeded in a material which acts as an electrical insulator as well as a conductor of heat. With this type of element, the pots or pans are in direct contact with the heat resulting in little or no heat loss. Also, the metal tube protects the heating element, inside, from damage.

Surface elements generally come in two different sizes, 6" and 8" units and are rated in wattages from 1500 to 2700 watts. They also come in two different types, two-wire elements and three-wire elements. Two wire elements consist of only one element wound in a spiral form and are designed to operate only on infinite switches (see Figure A). With this type of switch the operator may choose an indefinite number of heat positions.

Three wire elements consist of two heating elements an inner and outer element. One end of each element is connected together and is used as the common terminal. The other ends of the two elements are used as hot terminals (see Figure B). The three wire elements are used with step switches. With a step switch, a person may choose from three to seven different heat positions. Study the wiring of the two elements in Figure A and B.

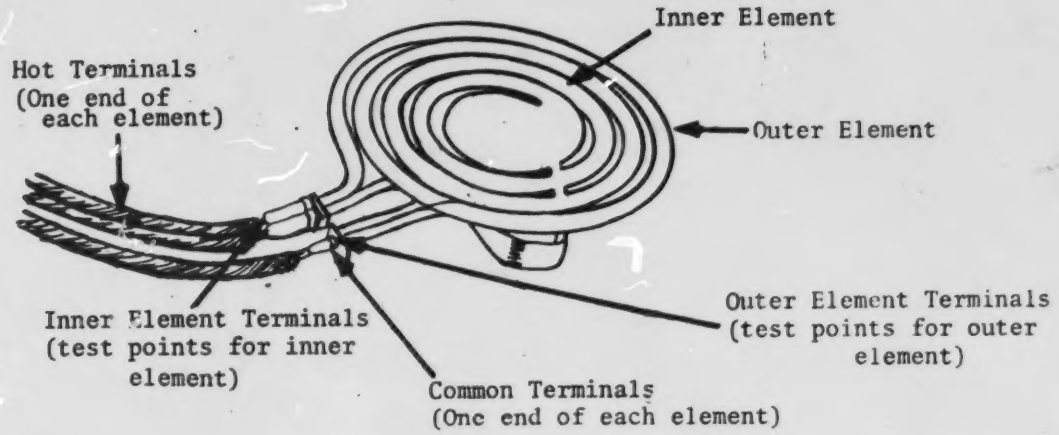
## FIGURE A

*Two-Wire Unit*




## FIGURE B

*Three - Wire Unit (Two Elements)*



PROCEDURES:

1. Secure one two wire element and one three wire element from the storage room and check out a V.O.M.

2. Zero the V.O.M. on the R x 1 selector range.

3. Visually inspect the two wire element. A burned spot in the metal tubing of the element usually means that the element has shorted out against the metal tube and is now open. Record your findings on the following page in Column B.

4. Take the two wire surface unit and place one test probe on one terminal of the element and the other test probe on the other terminal. (Refer to Figure C).

5. If the element is in good condition, it should read around 45 ohms. A high resistance in an element would cause an insufficient heat problem. A zero reading means that the element is shorted. This condition would cause the range to blow fuses each time it is energized. No reading on any selector range indicates an open element. This condition would cause a "no heat" problem. Record your readings on the next page in Column B and state condition.

6. Visually inspect the three wire element and record your findings in Column C.

7. Take the three wire wire element and place the test probes on one outside terminal, skip one terminal and place the other test probe on the common terminal (Refer to Figure D).

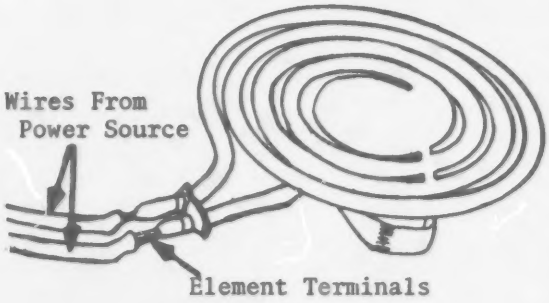
8. Record the resistance in Column C and state the condition.

9. Place the test probes of the V.O.M. on the inside terminal and common terminal.

10. Record the resistance in Column C and state the condition.

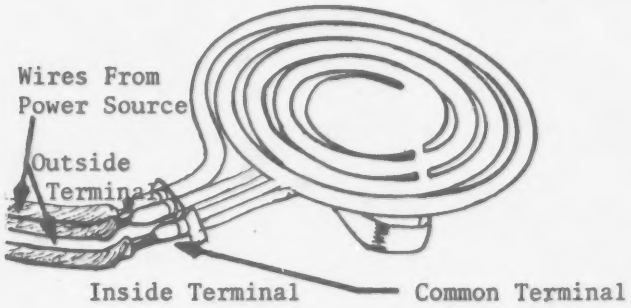
Element Test Results

| TYPE OF INSPECTION | TWO WIRE ELEMENT | THREE WIRE ELEMENT |
|---|---|---|
| Visual | | |
| Resistance | | #1 Element |
| | | #2 Element |




*Two-Wire Element Test Points*

FIGURE C




*Three-Wire Element Test Points*

FIGURE D

PROCEDURE:

1. Secure from the tool room necessary tools and equipment needed to remove, check, and install surface unit.

2. Go over to the surface unit provided by the instructor and record information on next page.

3. Use proper measures to remove the unit.

4. Measure the resistance of the left front (LF) element. (Remember the resistance should usually be 50 ohms or less).

5. Record your resistance in the provided.

6. If the unit is a three-wire element, make sure both outer and inner elements are checked and recorded.

7. Make your analysis as to what the condition of the element is and record.

8. Check all other elements moving from the left front to left rear. Then from left rear to right front and from right front to right rear.

9. Record the same information for each of the elements in the space provided.

10. Record your analysis in the space provided.

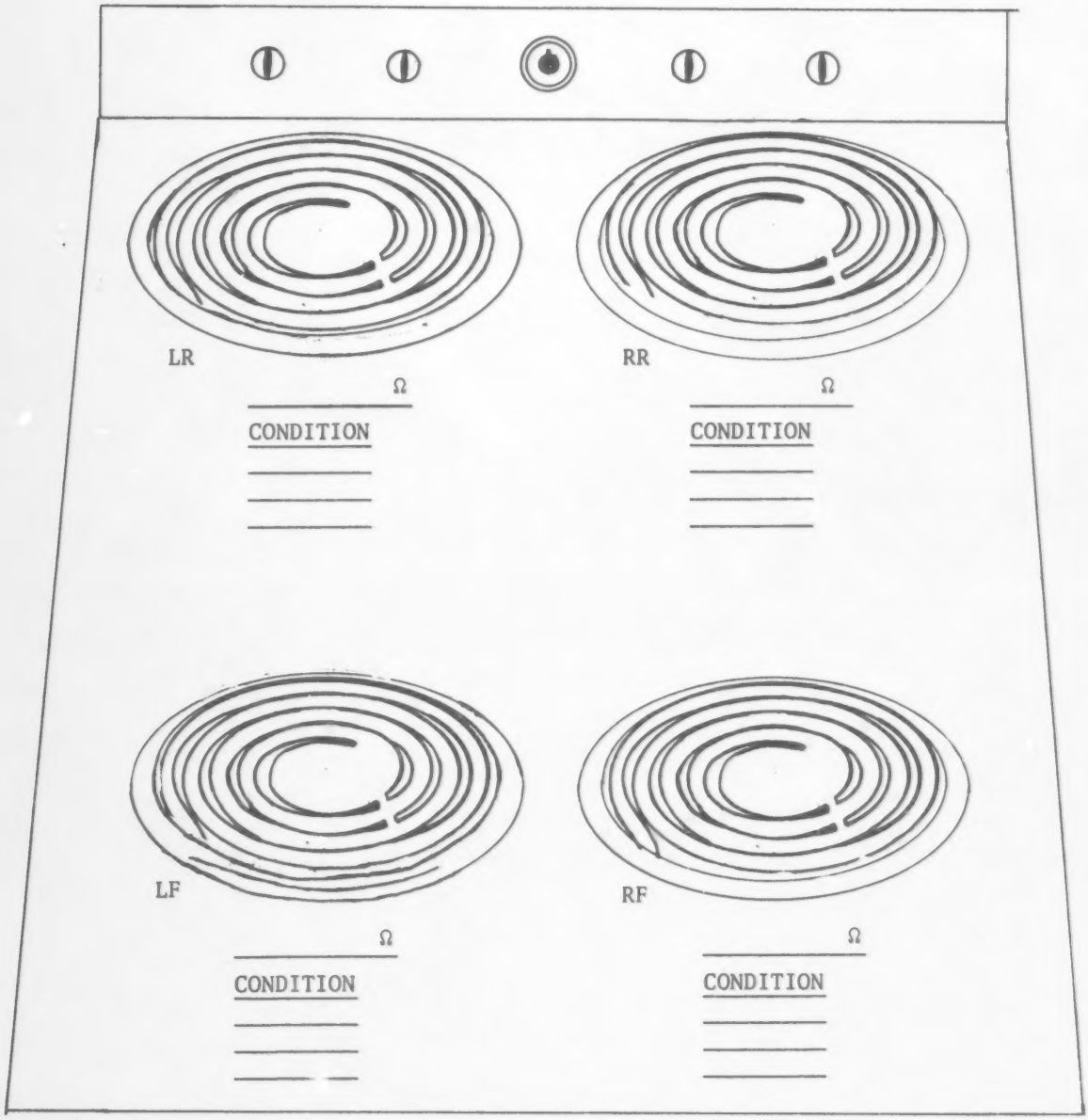
11. If you feel that any of the elements should be replaced, ask your instructor for a replacement.

12. Replace all elements and return the tools to the storage room.

Surface Unit Test Results

Manufacturer _____

Serial # _____



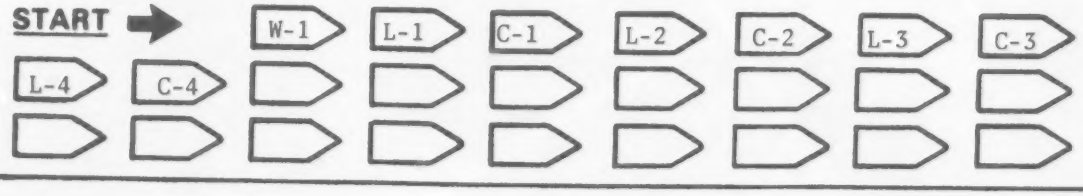
**MAJOR BLOCK** Major Appliances **NAME** _____

**TASK** Troubleshooting Electric Ranges

**UNIT** Testing and Replacing Surface Unit Switches **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-27

**OBJECTIVE(S)** Test and replace service unit switches




**WRITTEN ASSIGNMENT(S)**

**W-1** Text Assignment MA-27a
**W-2** _____
**W-3** _____
**W-4** _____
**W-5** _____
**W-6** _____
**W-7** _____

**AUDIOVISUAL(S)**

**A-1** _____
**A-2** _____
**A-3** _____
**A-4** _____
**A-5** _____
**A-6** _____
**A-7** _____

**LABORATORY ASSIGNMENT(S)**

**L-1** Job Sheet MA-27a
**L-2** Job Sheet MA-27b
**L-3** Job Sheet MA-27c
**L-4** Job Sheet MA-27d
**L-5** _____
**L-6** _____
**L-7** _____
**L-8** _____
**L-9** _____

**CHECKPOINT(S)**

**C-1** Instructor Check
**C-2** Instructor Check
**C-3** Instructor Check
**C-4** Instructor Check
**C-5** _____
**C-6** _____
**C-7** _____
**C-8** _____
**C-9** _____

## Test Step Switches Cold

Procedures: Testing step switches cold (refer to figures one through seven when making checks).

1. Secure multimeter from tool room.
2. Set the meter on the Rx1 selector range and zero in.
3. Begin checking by turning the selector switch to be checked to the high position. Place one test lead on the L1 terminal and the other on the common (C) terminal. The meter should read a direct short. If reading is ok, move the test leads to L2 and H2 and from L2 to H1. The reading should be the same as on the first check. (All diagnostic checks should be made in the same order as in the high position).
4. Turn the switch to the med. high position and check from L1 to C and from L2 to H2.
5. Note that as checks were made they were from the points at the ends of the dotted lines on the diagram. To finish checking the switch, turn the selector knob to the medium, medium low, low, very low, and simmer position, making the checks as in step 4 and 5 (also make diagnosis in each position).
6. If the switch proves to be bad in any position, it should be replaced.

Step Switches with 7-heat Positions

(Only Rear of Switches Shown)

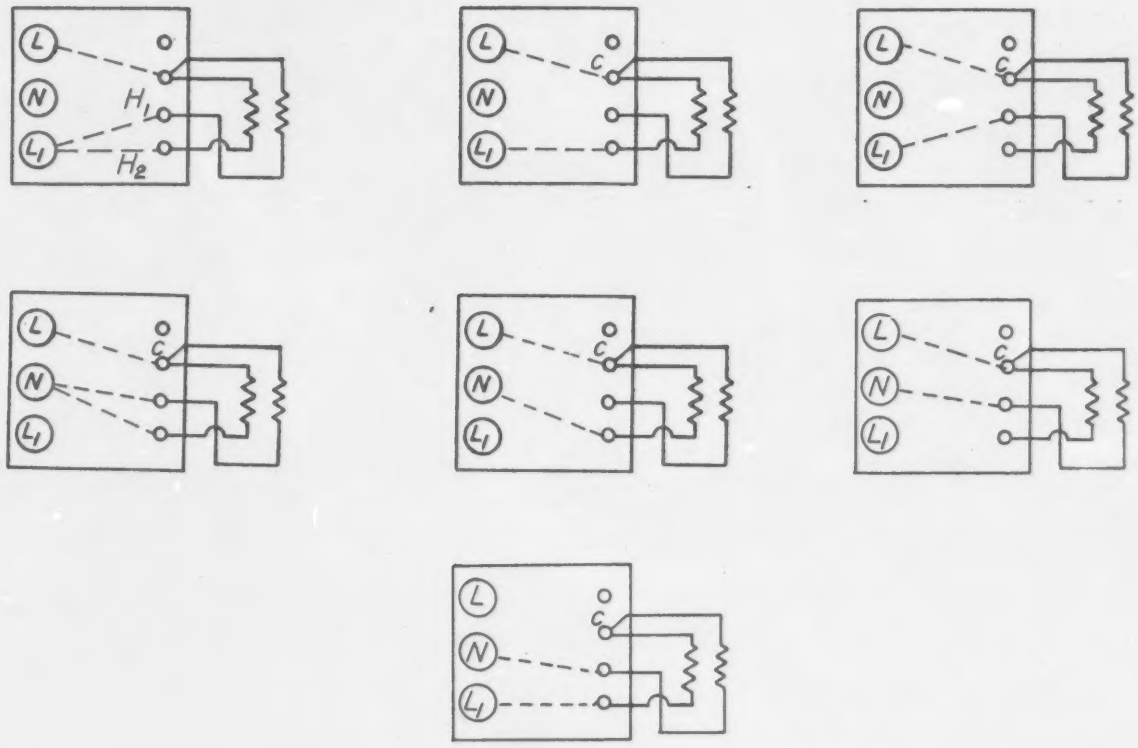



FIGURE A

Abbreviations: L1, L2-hot wires leading from cord.

N-Neutral wire from cord; H1, H2-wires to inside and outside element.

C-common wire to both, inside and outside elements.

# Testing Infinite Switches With Load

Procedures:

1. Secure 1 multimeter and test leads from the tool room.
2. Set the multimeter on the 250 V.A.C. scale.
3. Remove the surface switch cover plate and turn the range on.
4. Place one test lead of the multimeter on L1 and the other one on L2. The meter should read around 230v. If no voltage, test for voltage at the two outside terminals. If the meter reads 230v, then there is an open wire leading from the cord terminals to the input terminals of the switch (L1 and L2).
5. If voltage is measured at L1 and L2, turn the selector switch to the high position. Place test leads on the output terminals (H1 and H2). If no voltage is measured in high position, turn to a lower position, measuring from the same points. No voltage in any position means that the switch is bad and should be replaced.
6. Check remaining surface switches using procedures 4-5.
7. Make diagnosis as to which switches are bad and which one(s) are good.

# Test and Replace Infinite Switches

Procedures:

1. Secure multimeter from the tool room.
2. Set the meter on the 250v. range.
3. Remove switch cover plate.
4. Use procedures for testing infinite switches as described in Job Sheet MA-27b.
5. Test all infinite switches and make diagnosis as to which switch is bad.
6. Replace bad switch. (Replace one wire at a time).
7. Turn units on to make sure they work correctly.

## Test and Replace Step Switches

1. Remove the switch cover plate.
2. Set the meter on the Rx1 range.
3. Use procedures for checking step switches as described in Job Sheet MA-27a.
4. Test all step switches in the range.
5. Make diagnosis as to which switch is bad.
6. Replace the switch. (Notice which terminal each wire is taken from to be sure that the new switch is wired like the old one. Remove one wire at a time and place on the new switch).
7. Energize unit to see if surface unit works correctly on all selector settings.

**MAJOR BLOCK** Major Appliance **NAME** _____

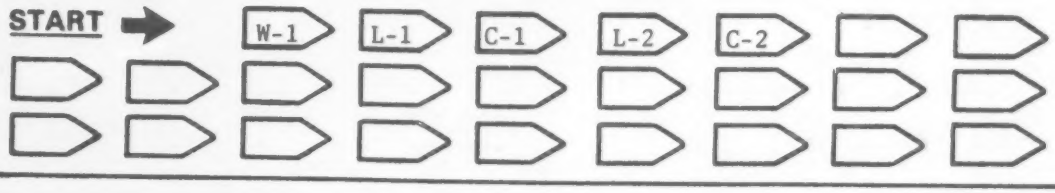
**TASK** Troubleshooting Electric Range

**UNIT** Testing and Replacing Oven Elements **TIME (est.)** _____ **(act.)** _____

**UNIT NO.** MA-28

**OBJECTIVE(S)**

Test and replace bake and broil heating elements on an electric oven.




**WRITTEN ASSIGNMENT(S)**

W-1 Information Sheet MA-28a
W-2 _____
W-3 _____
W-4 _____
W-5 _____
W-6 _____
W-7 _____

**AUDIOVISUAL(S)**

A-1 _____
A-2 _____
A-3 _____
A-4 _____
A-5 _____
A-6 _____
A-7 _____

**LABORATORY ASSIGNMENT(S)**

L-1 Job Sheet MA-28a
L-2 Job Sheet MA-28b
L-3 _____
L-4 _____
L-5 _____
L-6 _____
L-7 _____
L-8 _____
L-9 _____

**CHECKPOINT(S)**

C-1 Instructor Check
C-2 Instructor Check
C-3 _____
C-4 _____
C-5 _____
C-6 _____
C-7 _____
C-8 _____
C-9 _____

There are various types and sizes of bake and broil elements in an electric range. The bake elements, for example, will vary in shape and size between each manufacturer. The basic operation of the element, however, is the same, regardless of who manufactures it. The top element which is used to broil will normally have a mounting apparatus allowing it to hang in the top of the oven. The bake element will be equipped with a foot to rest in the bottom of the oven to raise it from the surface of the oven.

Three basic types of connections will exist on different models and manufacturers.

1. Plug-in element. It is installed by plugging in usually to the back of the oven much like a convenience receptacle. It is constructed in such a way that it can be easily removed for cleaning and service.

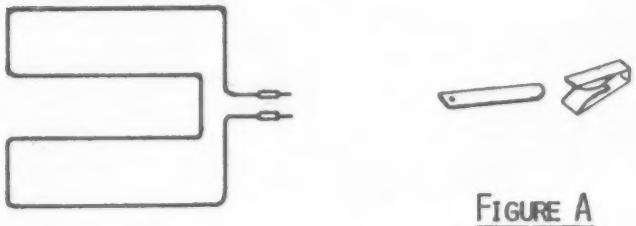


FIGURE A

2. Spade type element. This element has a metal mounting bracket which secures it to the back of the range. The electrical connection is made in the back of the oven inside the back panel using spade terminal.

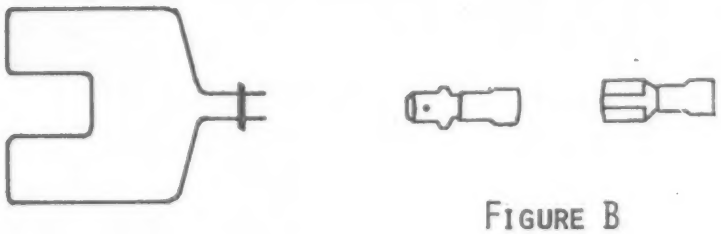


FIGURE B

3. Wire-in element. The mounting of the wire-in element is very similar to the spade element. Screws attach a plate to the rear inside surface of the oven. The terminal connection, however, must be wired to a terminal screw on the heating element. As the element is mounted to the oven, the wires are forced into a cavity inside the rear panel of the oven.

FIGURE C

The instructor will assign three oven heating elements for the purpose of testing. Determine the condition of the element and identify the element according to type of terminal, whether it is bake or broil and condition of the element.

1. Use an ohmmeter to check for an open or short circuit.

2. Attach leads of meter to terminals of element. If no resistance is indicated, the element is open. This means that the wiring circuit within the element is broken and will not operate.

3. A short circuit may be indicated by attaching one lead of the meter to one terminal of the element and the second lead to a ground on the oven or plate of the element. If resistance is apparent, a short circuit will exist in the element.

| | Type of Element | Bake/Broil | Condition of Element |
|---|---|---|---|
| Element #1 | _____ | _____ | _____ |
| Element #2 | _____ | _____ | _____ |
| Element #3 | _____ | _____ | _____ |

Steps to removal of bake or broil elements are quite simple. This can be done from inside the oven in most cases. Most elements have selftapping screws to hold it in place. These must be removed before the element can be pulled out. If the element is a plugin type, it simply unplugs. If it is any other type, the wires must be disconnected before it can be removed. After the element is removed, use the steps in the previous job sheet to test the element. Your instructor will assign you a range to check, remove the bake and broil element. Check them and reinstall them. Have your instructor check your work.

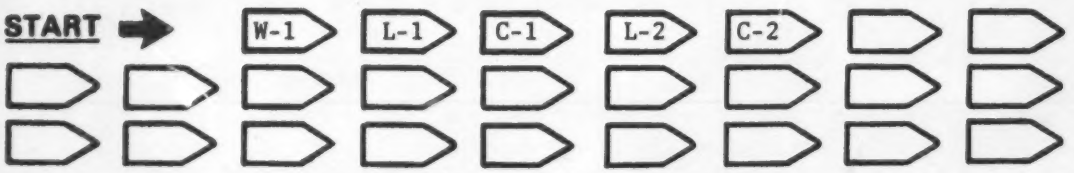
**MAJOR BLOCK** Major Appliances **NAME** _____

**TASK** Troubleshooting Electric Ranges

**UNIT** Testing and Replacing Oven Temperature Controls **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-29

**OBJECTIVE(S)** Test and Replace Oven Temperature Controls.




**WRITTEN ASSIGNMENT(S)**

**W-1** Text Assignment MA-29a
**W-2** _____
**W-3** _____
**W-4** _____
**W-5** _____
**W-6** _____
**W-7** _____

**AUDIOVISUAL(S)**

**A-1** _____
**A-2** _____
**A-3** _____
**A-4** _____
**A-5** _____
**A-6** _____
**A-7** _____

**LABORATORY ASSIGNMENT(S)**

**L-1** Job Sheet MA-29a
**L-2** Job Sheet MA-29b
**L-3** _____
**L-4** _____
**L-5** _____
**L-6** _____
**L-7** _____
**L-8** _____
**L-9** _____

**CHECKPOINT(S)**

**C-1** Instructor Check
**C-2** Instructor Check
**C-3** _____
**C-4** _____
**C-5** _____
**C-6** _____
**C-7** _____
**C-8** _____
**C-9** _____

The instructor will assign you a range and thermometer. Go to the range. Check for proper thermostat operation and calibration. If the unit is out of calibration, adjust it according to the steps found in the text assignment.

Record Temp. Set _____ Actual Temp. _____

Using your text as a guide, go to the assigned range. Remove the thermostat, inspect it, show it to the instructor. Find it in the price catalog, (if available), record price below and then reinstall it. Remember to be careful with the capillary tube removal and replacement.

Range Make _____

Model No. _____

Thermostat Part No. _____

Price _____

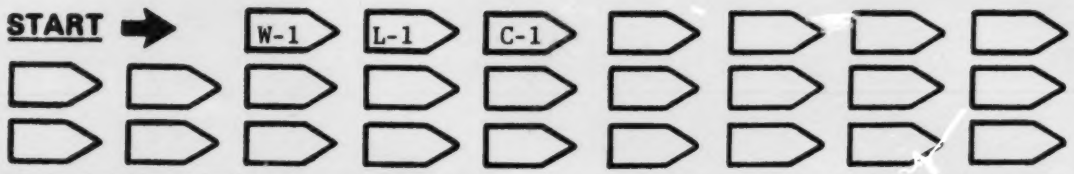
**MAJOR BLOCK** Major Appliances **NAME** _____

**TASK** Troubleshooting Electric Ranges

**UNIT** Replacing Automatic Timer **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-30

**OBJECTIVE(S)** Remove and replace an automatic timer on an electric range.




**WRITTEN ASSIGNMENT(S)**

**W-1** Text Assignment MA-30a
**W-2** _____
**W-3** _____
**W-4** _____
**W-5** _____
**W-6** _____
**W-7** _____

**AUDIOVISUAL(S)**

**A-1** _____
**A-2** _____
**A-3** _____
**A-4** _____
**A-5** _____
**A-6** _____
**A-7** _____

**LABORATORY ASSIGNMENT(S)**

**L-1** Job Sheet MA-30a
**L-2** _____
**L-3** _____
**L-4** _____
**L-5** _____
**L-6** _____
**L-7** _____
**L-8** _____
**L-9** _____

**CHECKPOINT(S)**

**C-1** Instructor Check
**C-2** _____
**C-3** _____
**C-4** _____
**C-5** _____
**C-6** _____
**C-7** _____
**C-8** _____
**C-9** _____

The instructor will assign a range to perform this job on. Check the timer using the procedure described in the reading assignment or range service manual. Remove the timer. Check the motor for continuity and also check the condition of the contacts. Be sure to mark the wires before removing them. Before reinstalling the timer have it checked by the instructor. Be prepared to describe the procedure for reinstalling it. When the instructor directs you to continue the job, reinstall the timer and perform an operational check of the range. Have the instructor check the completed job.

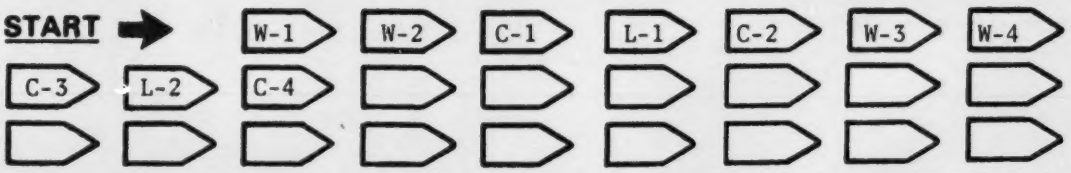
**MAJOR BLOCK** Major Appliance **NAME** _____

**TASK** Troubleshooting Electric Ranges

**UNIT** Service continuous cleaning and self cleaning ovens **TIME (est.)** _____ **(act.)** _____

**UNIT NO** MA-31

**OBJECTIVE(S)** Service a continuous cleaning and a self cleaning oven.




**WRITTEN ASSIGNMENT(S)**

| | |
|---|---|
| W-1 | Information Sheet MA-31a |
| W-2 | Assignment Sheet MA-31a |
| W-3 | Information Sheet MA-31b |
| W-4 | Assignment Sheet MA-31b |
| W-5 | |
| W-6 | |
| W-7 | |

**AUDIOVISUAL(S)**

| | |
|---|---|
| A-1 | |
| A-2 | |
| A-3 | |
| A-4 | |
| A-5 | |
| A-6 | |
| A-7 | |

**LABORATORY ASSIGNMENT(S)**

| | |
|---|---|
| L-1 | Job Sheet MA-31a |
| L-2 | Job Sheet MA-31b |
| L-3 | |
| L-4 | |
| L-5 | |
| L-6 | |
| L-7 | |
| L-8 | |
| L-9 | |

**CHECKPOINT(S)**

| | |
|---|---|
| C-1 | Instructor Check |
| C-2 | Instructor Check |
| C-3 | Instructor Check |
| C-4 | Instructor Check |
| C-5 | |
| C-6 | |
| C-7 | |
| C-8 | |
| C-9 | |

There are three types of ovens in use today - the regular oven, continuous-cleaning oven and a self-cleaning oven. Studied in an earlier unit was the operation of a regular oven. The continuous-cleaning oven is the same as the regular oven in operation but it has a special porcelain liner in the oven. The surface of the liner can be compared to a brick - it is rough, dark, and has little stipples. When food splatters or spills on it, the food disperses into the porcelain contour and breaks down in particles instead of forming drops like water forms on wax paper. When the oven is in normal use the temperature decomposes the food by organic oxidation. Sometimes the spill-overs or very large splatters can make a permanent stain, causing varnishing. There is no known method for cleaning this type of stain. Self-cleaning ovens will be explained on the next information sheet.

Assignment Sheet MA-31a

1. What are the three types of ovens?

_____

_____

_____

2. What is different between the regular and continuous cleaning oven?

_____

_____

_____

3. How does the continuous cleaning method work in cleaning spills and splatters? _____

_____

_____

4. What will cause varnishing in a continuous cleaning oven? _____

_____

_____

_____

The service on a continuous clean oven is the same as a regular oven except for porcelain repair. To repair the porcelain a repair kit is needed. Follow the instructions in the kit for porcelain repair. For servicing the oven components refer to the proper service manual.

The instructor will assign a range to repair and a repair kit. An instructor check is required upon completion.

The self-cleaning oven is the easiest method of automatically cleaning an oven. The self cleaning oven uses temperatures from 850° to 100°. The oven is kept at this temperature from 2 to 3 hours. During this time food soils in the oven are broken down by a chemical process called pyrolysis. Since the oven uses extremely high temperature there is a great deal of safety equipment on these models that is not found on the regular and continuous clean models. The self-cleaning oven uses thick insulation to hold the heat better and keep the outer casing of the oven cooler. There are also vents, special controls, locks and special thermostats used in this type of oven. The oven uses a special thermostat that controls the high temperature in the oven and puts power on the control locking the door shut after the oven temperature has risen to around 660° (depending on the model) in addition to regular functions during useage. The latch mechanism can be operated by either a solenoid or a special latch motor. If the oven uses a special lock motor it has a motor limit lock switch to cut the motor off after it has engaged and disengages the locking mechanism.

The oven also has two knobs on the timer that set the time desired for cleaning. One knob is start time and the other is stop time. If you want the range to start cleaning then set the stop time to the desired length of time you want the oven to clean and set all other controls. If you want the oven to start cleaning later on, push in the start knob and turn the knob clockwise to the time you want the oven to come on, then set the stop time, then all other controls, depending on the step by step procedure in setting the oven up for cleaning. For the specific model refer to the proper service manual or owners manual. The oven has indicator lights to show when the oven is in clean and when the door is locked for safety precautions. Some models, depending on the style, use a special fan motor that keeps the control panel and shell of the oven cabinet cool by circulating air. There is also a relay or relays used to break the current flow through the bake and broil units when the oven reaches temperatures higher than 850°.

1. What special way does a self-cleaning oven use to clean the oven compartment? _____

2. What temperatures does the stove reach? How long does it stay at this temperature? _____

3. What protective devices does the stove have to guard against severe burns from the excessive heat? _____

4. What special devices does the stove use that are not found on an average stove? _____

1. See the instructor for assignment to a self cleaning oven.
2. Using the following tips, service the assigned component

To check the thermostat for continuity refer to the oven's schematic (or proper repair manual) for normally closed and normally open contacts and terminal identification. With an ohmmeter test across the proper terminals to check the oven lock contacts, bake and broil temperature contacts, and clean cycling contacts. If the contacts are normally closed there should be continuity through the contacts. If the contacts are normally open there should be no continuity through the contacts.

To test the latch motor for continuity check across its two motor leads. There should be a reading with a small amount of resistance. Then check the motor to ground by putting one lead on a sufficient ground and the other on one of the motor leads. There should be no reading. To test the motor limit lock switch, refer to the proper service manual for terminal identification. This switch is normally a single pole double throw switch. With the switch removed, test across the proper terminal and the common terminal. There should be continuity through the switch, then push the switch plunger in and test across the other terminal and the common terminal, there should be continuity through the contacts.

To test the solenoids on a solenoid operated locking mechanism use an ohmmeter and test across its two terminals. There should be resistance through the solenoid.

To test for continuity in the fan motor that circulates air around the cabinet, use the ohmmeter and test across the motor's two leads. There should be continuity through its winding. Then test the motor to ground by going from one of the motor leads to a sufficient ground on the mounting bracket. There should be no continuity.

To test a neon operated clean and lock light, apply 110 volts or 220 volts (according to the voltage of the light) to the light. The light should burn. If it doesn't replace it. To test a regular resistance type light use the ohmmeter and test across its two terminals. There should be continuity through the light.

To test the relays on the self-cleaning oven, refer to the proper service manual for terminal identification. To test the resistor in the relay use an ohmmeter and test across the two proper terminals. There should be a reading. To test the relay contacts that make and break for the bake and broil units refer to the service manual for relay type and terminal identification and checking procedures.

To test the time for proper contact making and breaking refer to the proper service manual for terminal identifications. With an ohmmeter and the timer set to start timing the clean cycle for about 2 hours. Test across the two proper terminals. There should be continuity through the contacts. Then push in the timer start knob and turn the knob till the stop knob pops out. Test across the proper terminals for continuity. There should not be a reading on the meter.

For the removal of any of these components refer to the proper service manual for panel removal and component removal.